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IO AND ITS HABITS.

BY DR. JAMES LEWIS.

IN a mountainous region comprising adjoining portions of the States of Virginia, North Carolina, Tennessee, and Kentucky arise numerous small streams which unite to form the principal rivers which are the head-waters of the Tennessee River. All these streams, not excepting the upper portions of the Tennessee River itself, have in a greater or less degree the characters of mountain torrents, which in reality they seem to be on a very grand scale. The streams have very usually a rapid descent, and are in many places broken by shoals and rapids, the beds of the streams being usually coarse gravel or rock; there are seldom to be found stretches of placid water, and accordingly, as might well be conjectured, the fauna of the region, so far at least as relates to fresh-water mollusks, is somewhat peculiar. In the gravelly portions of some of the streams abound numerous species of Unio; on bars and shoals are found immense numbers of operculate univalve mollusks, and in the rapids, especially in rocky portions of the principal rivers, are found the beautiful and interesting shells of species of Io, which are the largest and most attractive univalves of the family to which they belong. The earliest account we have of this group of shells may be found in the *Journal of the Academy of Natural Sciences*, November, 1825, in which Mr. Say described a species found in the North Fork of the Holston River in Virginia, calling it *Fusus fluvialis*. From that time until quite recently, additional species have from time to time been published, all of them being referred to the Holston River or more vaguely to "Tennessee." Even so late as 1873, there was only a single record showing that Io had been found in any stream other than the Holston River. The record here alluded to occurs in the *American Journal of Conchology*, vi. 223, and bears date October

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24, 1870. If there were any persons aware of the occurrence of Io in streams other than the Holston River prior to that date, they probably had reasons for not publishing the fact. Since the date quoted, however, it has been ascertained that the distribution of Io extends to several streams in East Tennessee, rendering it quite probable that future explorations may lead to its detection in the southern part of Eastern Kentucky, and in the northern part of Western North Carolina. At the present time Io is known to occur in the following streams: North Fork of the Holston in Western Virginia; in the Holston River in East Tennessee; in the Tennessee River as far south as Bridgeport, Alabama; in the Nolachucky and French Broad rivers in Jefferson County, Tenn.; in the Clinch River at Black's Ford, Anderson County, Tenn., and at Williams' Ford in Roane County, Tenn.; and in Powell's River at Kraushorn's Ferry, near the State of Kentucky.

Observers who have made any records of the habits of Io agree in stating that the shells are found only in swift water, though there appear to be discrepancies as to the abundance of specimens, which may indicate that some localities are more favorable for them than others. It must be inferred that Io, living in streams the currents of which are very rapid, is specially organized, and adapted to the situations in which it is found. Such, indeed, seems really to be the case; for a lady who collected specimens in some of the rivers of Tennessee wrote of them as follows: "The muscular power of Io is astonishing. I frequently find one adhering to a rock half as large as my head, and when I take up the shell it brings the rock with it, and requires much force to separate it." [1]

It is somewhat strange that shells of so much beauty as some of the species of Io display are scarcely known to the inhabitants dwelling in the neighborhood of the streams in which they occur; yet it seems, from records made of the contents of ancient burial places, that they were known to the people who inhabited the country prior to the advent of European races. Mr. Lea, writing upon this subject,[2] makes the following suggestive remark, which conveys a great deal in a few words: "Professor Troost informs me they [Ios] are rare in the river [Holston]; that they had been observed in the graves of the aborigines; and as it was generally believed that these were 'conch shells,' consequently coming from the sea, it was urged that the inhabitants who possessed

[1] American Journal of Conchology, vi. 223.

[2] Observations, etc., i. 224.

them must have come over the sea. It does not appear that they [Ios] had been observed in their native element, though living at the very doors of the persons who had remarked them in the tumuli." The impression that Io is a "sea-shell" is one that strikes most ordinary observers at first sight, as every collector who has them can testify.

Quite a considerable number of species of Io may be found described and figured in various works treating on the shells of North America, and there is considerable diversity exhibited in their forms, sizes, colors, and markings. There seems to be considerable difference of opinion among persons who have studied these shells, as regards the number of species. There are some individuals who with apparent good reason believe that there is really only one species of typical Io, to which all the forms are subordinate as varieties; while on the other hand we shall find others who for reasons quite as good insist that there are five or more "good species." The shells, taken by themselves, without regard to any facts relating to their habits, do not afford conclusive testimony as to species, as it is exceedingly difficult to isolate forms that cannot be made part of a continuous series when large numbers of shells are placed together. There are, however, some facts connected with geographical distribution and the association of varied forms, which seem to indicate conclusively that there are certainly two species; and, this being admitted, the logical inference might be, under all the circumstances which remain unconsidered, that there are more than two species. This, however, is a question which remains to be investigated. The facts upon which two species are inferred are the following. At Black's Ford, Clinch River, Anderson County, Tenn., two forms of Io constitute very nearly all that are found at that particular locality, and these two forms occur there in about equal numbers, and there are not associated with them any intermediate forms uniting the extremes. Thirty or forty miles down the river (following its winding course), at Williams' Ford in Roane County, these same two forms reappear, but their relative numbers have changed. At this point the form which seems to be identical with a shell figured by Reeve as *Io turrita* (not Mr. Anthony's species of that name, by any means) is the shell occurring in fewest numbers, while the prevailing form is a graceful, slender variety of the shell that Mr. Lea calls *spinosa*. The change in the relative abundance of two forms by a change of station seems to afford evidence relative to species. In following out the train of ideas which this

suggests, it is perhaps appropriate in this connection to glance at the subject of geographical distribution as it relates to other forms, and suggest some of the conditions that seem to be correlated to the diverse forms. A little reflection will satisfy the most casual observer that the conditions under which Io is found are subject to variations of no small magnitude. First to be considered is the climatic condition, affected by the combined influences of latitude and elevation, conspiring in the northern limit of the region inhabited by Io to produce a lower mean annual temperature than may be inferred at the southern limit. There may be in all a difference of four or five degrees of latitude, and possibly from two hundred to four hundred feet difference in elevation. In the northern portion of the area inhabited by Io are found those forms destitute of spines, associated with others in which the spines are only rudimentary or reduced to mere tubercles. To the southward, the smooth forms diminish in numbers, and disappear entirely before the central latitude of Tennessee is reached, and as a warmer climate is approached the development of the spines becomes more and more luxuriant. This is true of the Holston River in Virginia and Tennessee, and recent observations have detected a similar state of facts in the Clinch River and its tributary, Powell's River. Besides the influences of climate dependent on latitude and elevation, it may be conjectured that there are other influences affecting Io, some of them in a considerable degree depending on the mineral properties of the water due to the variable qualities of rock and soil among the mountains of that region. In evidence of this may be suggested the differences in size and appearance of shells from different streams.

In correlating these differences we shall find the most robust Ios in the Holston River. The roughest shells, as regards the whole surface, occur in French Broad River. The most slender and graceful forms are found in Clinch River. The smallest adult forms occur in Powell's River, where there are also other peculiarities observable that contrast curiously with what is known of Io elsewhere. The tubercular and spinous forms of Powell's River exhibit their characteristics (spines and tubercles) in a more rudimentary form than those found else where, and on averaging the specimens it will be observed that they appear to have one whorl less, and more spines or tubercles on each whorl, than is observable in the more luxuriant forms of other localities. How much of all the differences in forms here suggested is ascribable to species

is not at this time a subject of inquiry. In color, the shells of French Broad River are remarkable for green tints in the epidermis. In the Holston River the tints are somewhat ferruginous, but not to the same extent observable in the shells of Powell's River; while in Clinch River the epidermis is often of a bright yellow or orange, varied by livid tints which are partaken of by many other univalve mollusks inhabiting that stream.

The reader may possibly have felt, in reading a portion of this paper, some curiosity to know why Io occurs only in the upper waters of the Tennessee system of drainage. In the introductory paragraph of this paper it was stated that "all these streams, not excepting the upper portions of the Tennessee River itself, have in a greater or less degree the characters of mountain torrents, which in reality they seem to be on a very grand scale." From what we now know of Io we may infer that it cannot exist in placid rivers, and the limit of its distribution south in the Tennessee River depends on the character of the river. At the point where the Tennessee begins to be a majestic, placid stream, there Io ceases to extend its domain. This very simple inference is a key to the solution of other problems relating to the geographical distribution of allied forms in the same great family of mollusks. Very many of the univalve mollusks of the Tennessee drainage abound in swift shoal water, among rocks over which the water flows in broken torrents, and nowhere among still waters. The Tennessee River at Mussel Shoals is very prolific in various forms of mollusk life which delight in a rapid current; but below that point, in the navigable portions of the stream, very many of these interesting species disappear, because the conditions are no longer favorable to their existence.

Thus far, in the main, only the typical Io has been considered. There is another group of shells very nearly allied to Io, known by the generic designation *Angitrema*. Mr. Reeve regarded these shells as properly belonging in the genus Io; but his views do not seem to have met with much favor by writers on American conchology on this side of the Atlantic. Notwithstanding this evident difference in opinion, there is much reason for believing that Mr. Reeve's position is a good one, for some of the species of Angitrema are apparently related to Elk River, the Cumberland River, and some of its tributaries, as Io is to the head-waters of the Tennessee River. Indeed, it appears to be true that near the point where Io begins to disappear in the Tennessee River in Alabama, some of the forms of Angitrema replace it. The ques-

tion of the relative geographical distribution of Io and Angitrema, taken in connection with obvious resemblances in the shells detected by Mr. Reeve, seem to favor the suggestion that Angitrema is but a minor phase of Io. In habits the animals, so far as is known, are somewhat similar to each other, with this difference, that Angitrema is fitted to dwell in more quiet waters than the necessities of Io require.

Taken in another aspect, the inquiry why Io should be confined apparently to the head-waters of the Tennessee River can be answered (in the proverbial Yankee style) by offsetting the inquiry why a curious group of shells with a fissured lip should be found only in the Coosa River in Alabama. This, like much more that might be made the subject of inquiry, is a part of the unwritten history of Io that remains to be investigated.

The reader who may desire to refer to a summary of what has been written on species of Io will find such information as is available for the purposes of a naturalist in a work entitled Strepomatidæ, by G. W. Tryon, Jr., Smithsonian Miscellaneous Collections, No. 253.

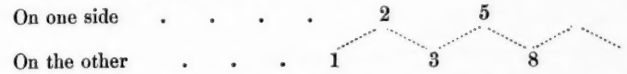
A POPULAR EXPLANATION (FOR THOSE WHO UNDERSTAND BOTANY) OF THE MATHEMATICAL NATURE OF PHYLLOTAXIS.

BY THE LATE CHAUNCY WRIGHT.[1]

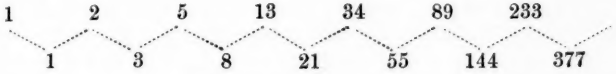
TAKE, by the finger and thumb of your right hand, hold of a spike of *Plantago major*, *Lepidium Virginicum*, or other flower-cluster with symmetrically crowded flowers, and with the finger and thumb of the left hand grasp it a little higher up, so as to include between the two hands a dozen or twenty buds on a piece of stem about equally tough from end to end. Twist the stem, and if it twists equally in all parts you will bring your buds into a small number of ranks, let us say 8. By twisting a little in the opposite direction you will get them into 5 ranks. Twist harder, and if your stem is tough enough to stand the twist you will bring them into two ranks. Turn back to 8 rows, and twist harder in that direction; you will fetch your buds into 3 rows. Then twist still harder in that direction, and if you have an old, tough, plaintain spike, you may get the seed-vessels all into one row before your stalk is twisted off.

[1] This article was prepared by Mr. Wright several years ago, at Professor Gray's suggestion. In its manuscript form it has been found of much interest and value to the botanical students in Harvard College. It is here reprinted without change from Mr. Wright's notes.

Thus by mechanical twisting, if the twist is equal in all parts of the stem, we get on one side of the natural position the number of rows 5 and 2, and on the other side 8, 3, and 1. Hence if we begin with the most twisted position and come toward the natural position, we get the numbers



Now these series of numbers indicate the approach towards the untwisted position. What would be the number of ranks in that theoretically perfect untwisted state? As both these series of numbers are increasing, that is, the number of ranks decreases as you twist either way, you may infer that in the untwisted state the number of ranks is prodigious or innumerable. Carrying on the series by adding zigzag as the lines are dotted, we should get



Hence we say that the slightest conceivable twist in one direction makes the number of ranks 377, a little more in that direction gives 144, 55, 21, 8, 3, 1, while the slightest twist in the opposite direction gives us 233, a little more 89, 34, 13, 5, 2, 1.

There is, however, a mystery in the space between 233 and 377, between twisting one way and twisting the other. Let us not seek to solve it by running the number of ranks up higher, to 610, 987, 1597, etc., but approach it in another way.

In the stem twisted one way, the angle between the leaves is $\frac{1}{2}$ the whole circumference, or $\frac{2}{5}$, or $\frac{5}{13}$, or $\frac{13}{34}$, etc.; with the stem twisted the other way the angle is $\frac{1}{3}$, or $\frac{3}{8}$, or $\frac{8}{21}$, or $\frac{21}{55}$ etc., the circumference. Let us set these in double rows: —

Twisted one way . . .	$\frac{1}{2}$	$\frac{2}{5}$	$\frac{5}{13}$	$\frac{13}{34}$	$\frac{34}{89}$	$\frac{89}{233}$.	
Twisted the other way . .	$\frac{1}{3}$	$\frac{3}{8}$	$\frac{8}{21}$	$\frac{21}{55}$	$\frac{55}{144}$	$\frac{144}{377}$.	

Or putting them in decimals we shall see how they converge towards the same value: —

Twisted one way . .	.5	.4	.38	.382	.38202
Twisted the other way .	.33	.375	.3809	.3818	.38194

Take the high fraction $\frac{1597}{4181}$ in the upper series and turn it into decimals, we get .38196603. If the leaves were at this angle they would form 4181 rows or ranks, and the least twist would produce the lower numbers. Let us now attempt to find some

simpler mode of representing these fractions .38196603 or $\frac{1597}{4181}$, which are the same.

Dividing both numerator and denominator of $\frac{1597}{4181}$ by 1597 will give $\frac{1}{2}+\frac{987}{1597}$; dividing each term of the last fraction by 987 gives us

$$\frac{1}{2+}\,\frac{1}{1+}\,\frac{610}{987}$$

and continuing the process gives us

$$\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{377}{610}$$

equal to

$$\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{233}{377}$$

equal to

$$\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{144}{233}$$

equal to

$$\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1+}\,\text{etc.}$$

Now calling the fraction

$$\frac{1}{1+}\,\frac{1}{1+}\,\frac{1}{1}$$

continued indefinitely by the name of x, it is plain that the phyllotactic fractions beginning with $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$ continually approach nearer and nearer to the value $\frac{1}{2+x}$, or

$$\frac{1}{2+}\,\frac{1}{1+x}$$

or

$$\frac{1}{2+}\,\frac{1}{1+}\,\frac{1}{1+x}$$

and these values are alike. Putting the first two equal gives $\frac{1}{2+x}=\frac{1}{2+\frac{1}{1+x}}$

whence

$$x^2+x=1,\ x=-\tfrac{1}{2}+\tfrac{1}{2}\sqrt{5},\ \text{and}\ \frac{1}{2+x}=\tfrac{1}{2}\,(3-\sqrt{5}).$$

This expression, $\frac{1}{2}\,(3-\sqrt{5})$, is equal to .38196+, and expresses the exact ratio of the leaves in a theoretically untwisted stem when the number of rows is infinite. Other arrangements

are simply approximations to this (as though they aimed at this but got the stem twisted in growing), such as

$$\tfrac{1}{1+\frac{1}{1}}=\tfrac{1}{2} \qquad \tfrac{1}{2+\frac{1}{1}}=\tfrac{1}{3}$$

$$\tfrac{1}{2+\frac{1}{1+\frac{1}{1}}}=\tfrac{2}{5} \qquad \tfrac{1}{2+\frac{1}{1+\frac{1}{1+\frac{1}{1}}}}=\tfrac{3}{8}$$

TRACES OF AN AMERICAN AUTOCHTHON.

BY DR. C. C. ABBOTT.

WHEN in our rambles over the fields, in search of relics, we chance to find lying side by side some rough, rude implement and a delicate, artistically-wrought arrow-point, we are apt to merely glance at the former, and perhaps smile at so poor an effort at flint-chipping, while admiring the beauty of finish and excellence of workmanship displayed by the latter. But the unshapely implement has a history that, if not as eloquent as the legends of the red man, is far older, and calls up a shadowy vision of a still more distant time, when another people dwelt in this goodly land, and fashioned for its use these rude stone weapons that now alone are left to tell its story, and recall the time when this "great continent was occupied by a wide-spread though sparse population."

During the summer of 1872, having heard of the occurrence of Indian relics in a gravel bank then being removed, I carefully examined the face of the bluff, and succeeded in finding a single stone implement, and subsequently two others. These three specimens were described and figured soon after,[1] and I then expressed the opinion that, "had but a single specimen been found, we might reasonably, perhaps, have applied to it the doctrine of chances, and maintained that it was merely a freak of nature; but the occurrence of three specimens so near each other effectually disposes of the justice of such an opinion, and we must admit the antiquity of American man to be greater than the advent of the so-called Indian."

I have lately succeeded in finding a few specimens of relics, in strata of river drift, similar to those figured in the NATURALIST, but higher up in the series; thus apparently connecting them with the rude forms found near and occasionally on the surface, which I formerly believed to be the forerunners of the later

[1] The American Naturalist, vii. 204.

relics. The intermediate specimens above referred to, seven in number, are rudely wrought lance-heads (?) and those ridge-backed, flat-bottomed implements, known locally as "turtle-backs." The supposed lance-heads are very similar to the European palæolithic forms, and in all respects identical with those found nearer the surface, of which the late Professor J. Wyman said,[1] in a notice of a series sent him, "There are several implements which very closely resemble the celts of the drift period of Europe, especially those found at St. Acheul, two or three of which, except for their material, could hardly be distinguished from them."

My studies of these palæolithic specimens, and of their position in the gravel beds and overlying soil, has led me to conclude that not long after the close of the last glacial epoch man appeared in the valley of the Delaware, and that during his occupancy there was a steady but not violent physical change of the general surface of the country, caused by the greatly increased volume of the river then nearly filling the present valley; and that at a point in time when the river (Delaware), diminished to its present size, occupied its present channel, these palæolithic people were driven off by the Indians, who at that time were themselves not advanced to the neolithic or polished-stone age condition. On examining a series of stone implements gathered from some one spot, we find one characteristic, common to all, which at once attracts the attention. This is the uniformity of the workmanship. As remarked by Professor Geikie, "The weapons and implements belonging to the older or palæolithic period are altogether of ruder form and finish. They are merely chipped into the requisite shape of adze, hatchet, scraper, or whatever the implement may chance to be. Although considerable dexterity is shown in the fashioning of these rude implements, yet they certainly evince much less skill on the part of the tool-maker than the relics of the newer or neolithic period. It is somewhat noteworthy also that while the implements of the neolithic period are made of various kinds of stones, those of the palæolithic period consist almost exclusively of *flint;* and so characteristic are the shape and fashion of the latter that an experienced archæologist has no difficulty in recognizing and distinguishing them at once from relics of the neolithic age."[2]

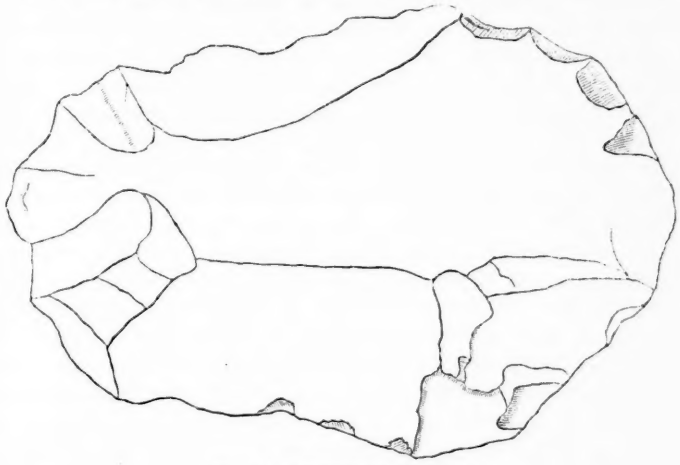
With the exception of the use of the word "flint," the above

[1] Fifth Annual Report of the Peabody Museum of Archæology, page 27. Cambridge. 1872.

[2] Great Ice Age, American Edition, page 404.

is in every way applicable to the rude implements here considered to be the production of an older people than the Indians.

Again, on examination of a large series of these relics, considered with reference to the circumstances under which they were gathered, it is found that the mineral of which they are almost exclusively made is not really a soft stone, easily worked; nor on the other hand as dense as jasper or quartz. A freshly fractured surface will readily scratch glass. Their surfaces are, however, quite soft, from long exposure since their detachment from the parent rock. In fragments of a rock buried in ordinary soil, and not exposed to unusual chemical action, any decomposition, if it took place at all, must have been very gradual; indeed, inconceiv-



(Fig. 21.) "TURTLE-BACK" CELT.

ably slow; and it seems more probable that these implements were long exposed to the weather on or near the surface of the ground, before the slowly increasing deposit of soil or stratum of sand or gravel, as the case may be, concealed them from view. This "weathering" of the surface of rude implements varies considerably in depth, but is not more noticeable on any one pattern of the few forms common to these older relics. It occurs on all, and the variation, ranging from $\frac{1}{32}$ to $\frac{1}{128}$ of an inch, indicates, I believe, a greater antiquity of the more deeply corroded specimens. A peculiarity which also tends to separate these rude relics from the more common or true Indian relics is the prevalence of certain forms of a marked character, which do not occur

of jasper, quartz, or other minerals used by the Indians. The most marked of these forms is that here figured, which I call, adopting the local name, a "turtle-back." The name quite accurately describes this peculiar form of stone implement. It is only necessary to say that they are flat upon the under side, usually presenting but one surface; and where two or three, the lines of separation are scarcely definable, and the specimen, when placed upon a level surface, appears to be perfectly smooth underneath. They vary but little in size, the one here figured (Figure 21) being an excellent example of an average specimen of this form of stone implement.

Considering this turtle-back as the primitive form of these palæolithic implements, we find that they vary from it, in three directions: towards the common grooved ax, but never with a groove; into spear-heads and large arrow-points; and into scrapers, such as the Indians later used. But while we meet with palæolithic axes, spears, and scrapers which are quite similar to the neolithic forms, they can never be confounded with them; the workmanship is quite distinct, and, however unusual its shape, there is that about it that marks it as *not* an ordinary Indian relic.

It is well here to refer to the fact that the occurrence of rude implements such as are here described takes place not only in this neighborhood, but Mr. C. C. Jones, in his work on Indian antiquities,[1] alludes to "some rudely-chipped, triangular-shaped implements found in Nacoochee Valley under circumstances which seemingly assign to them a very remote antiquity. In material, manner of construction, and general appearance, so nearly do they resemble some of the rough so-called flint hatchets belonging to the drift type, as described by M. Boucher de Perthes, that they might very readily be mistaken the one for the other. . . . . At a depth of nine feet below the surface, intermingled with the gravel and bowlders of the drift and just above the rocky substratum upon which the deposit rested, were found three flint implements. . . . . That the implements in question were brought down with and deposited in the drift when as yet there was little or no vegetable life in the valley, seems highly probable. How many centuries have looked down upon the gradual accumulation of the soil which now overlies the drift, none can answer; but of one thing we may rest satisfied, that these specimens of the rude labor of prehistoric man may well

[1] Antiquities of Southern Indians, page 294.

claim high antiquity. . . . . Thus, in Nacoochee, while the neolithic age is richly represented, the palæolithic period is not entirely wanting in its characteristic types."

The above well describes what obtains in the valley of the Delaware, except that the palæolithic period is quite well represented, and without so abrupt a break between that and the neolithic age.

Having, I trust, made the reader sufficiently familiar with the more prominent characteristics of these rude implements, as compared with the common forms of Indian relics, I propose now to determine, if possible, something concerning their origin; and to suggest to what race these palæolithic folk belonged.

If it is true that the relics of preoccupying races, now scattered over the State, are traces of two distinct peoples, it is obvious that either the older occupants of the territory passed away before the advent of the Indian, or they were driven from the country by the latter race. Had the palæolithic folk disappeared from the valley of the Delaware at some time long prior to the advent of the Indian, there would have been a break in the series of stone implements now found, and no commingling whatever, for a people once established would totally disappear only in consequence of geological changes occurring; and such would sufficiently alter the surface of the country to embed the relics in strata at some distance beneath the soil. Marked changes in the contour of the territory here considered have certainly taken place since the first appearance of man in eastern North America, but these changes have been so gentle as not to destroy the habitability of the country, and we therefore find the traces of that earlier people not only in the underlying gravels, but in the soil above, proving, I think, that palæolithic man did not disappear at a point in time anterior to the Indian's first appearance. It must be remembered, too, that the Indians claim to have been a usurping people; to have found, on their arrival, a preoccupying people, whom they dispossessed of their lands. If such is the case, — and do not the deeply buried rude relics here described authenticate their statements? — then two questions naturally arise in one's mind: Who were these ancient people? Where are they now?

It is scarcely probable that a race driven from their homes in the valley of the Delaware should have entirely left the country. They could not have crossed the ocean; and we look at the neighboring peoples to find the descendants of this displaced

people, if indeed they have not perished from off the face of the earth.

Have we near at hand any people that even in some respects meet the requirements of our supposition? I believe we have, in the Eskimo.[1]

The similarity of the Delaware Valley implements to those of Europe, as already referred to, is even more marked when the former are compared with the relics from French caves. The stone implements figured by Lartet and Christy,[2] illustrative of the weapons, domestic utensils, and ornaments of the reindeer people of Southern France, are, in part, so exactly reproduced in the palæolithic relics of New Jersey, that a close relationship of the two peoples suggests itself; although no caves such as are found in France, or engravings of extinct mammalia, have been discovered here.

In the brief space allotted to a magazine article, it is not practicable to enter minutely into detail with reference to the many facts having direct bearing on the question of the gravel-bed implements, their antiquity and origin. I have but briefly referred to the marked resemblance between New Jersey and French cave specimens of stone relics, and will here only add that "it would be easy to cite many circumstances illustrative of the resemblance between the condition and habits of the modern Eskimo and these cave dwellers of France at the reindeer period."[3] If, therefore, the rude implements of the Delaware Valley gravels resemble those of the caves of France, and the French troglodytes were identical (?) with the Eskimo, it is fair to presume that the first human beings that dwelt along the shores of the Delaware were really the same people as the present inhabitants of Arctic America.

It has been demonstrated, I believe, conclusively, that some eighty thousand years ago the last glacial epoch came to a close.[4] There was, however, no sudden change in the climate. The

[1] Since the above was written, I have received Nature for December 9, 1875, and find the statement there made, in a review of Dr. Rinks's Tales and Traditions of the Eskimo, that that author "is strongly of opinion that the Eskimo are an indigenous American people, who have been pushed northwards by the intrusive Indian tribes." This opinion of Dr. Rinks's, it will be noticed, if correct, is confirmatory of that taken in this paper, and in the February number of this journal, as to the traces of successive occupation of this country by two peoples, as indicated by the relics now found here.

[2] Reliquiæ Aquitanicæ. London. 1865–74. Edited by T. Rupert Jones.

[3] Reliquiæ Aquitanicæ, page 26.

[4] Climate and Time, by Croll; Great Ice Age, by J. Geikie.

winters were more severe than now, the summers shorter, and the reindeer still abundant. At this time, the river, now occupying a comparatively small and shallow channel, flowed at an elevation of nearly fifty feet above its present level; and it was when such a mighty stream as this, that man first gazed upon its waters and lost those rude weapons in its swift current that now, in the beds of gravel which its floods have deposited, are alike the puzzle and delight of the archæologist. Had these first comers, like the troglodytes of France, had convenient caves to shelter them, doubtless we would have their better wrought implements of bone to tell more surely the story of their ancient sojourn here; but, wanting them, their history is not altogether lost, and in the rude weapons, now deep down beneath the grassy sod and flower-decked river bank, we learn at least the fact of the presence, in the distant past, of an earlier people than the Indian, and have a veritable trace of the American autochthon.

JOHNNY DARTERS.

BY D. S. JORDAN AND H. E. COPELAND.

ANY one who has ever been a boy, and can remember the days of green meadows, tag alders, and an angleworm on a pin hook, surely has not forgotten the little dusky fish which lay perfectly motionless on the pebbly bottom of the shallow stream, untempted by fly or worm, while over his head the silly little minnows strained their toothless mouths in a vain endeavor to swallow the bait meant for the nobler sun-fish. You will remember, too, that when, after watching him a while, you put down your hand to catch the little philosopher, just as you had covered him and were sure you had him he was resting as composedly as ever a few feet farther up the stream. That little fish was a Johnny Darter.

It is an ancient and venerable family, that to which he belongs, the family of Darters. It is exclusively American, but none the less ancient and venerable on that account, for its members in every pond and brook of our Eastern United States trace back their lineage through a dozen lines of descent to a primitive darter, which lived and loved a million of years before the time of David Bruce or William the Conqueror.

The naturalists know them as *Etheostomoids*, from *Etheostoma*, the name given by Rafinesque to the first ones described, for

until 1820, no writer on such matters supposed the Johnnies to be fully developed fishes, but thought them the young of some perch or bass. Even for twenty-five years later, the wise men of the East who study nature in books and bottles, and do not know her when they meet her out-of-doors, spoke of Etheostoma as a mere "myth," having "no existence save in the fertile brain of men of versatile but disordered intellect," as they were pleased to style Rafinesque and others who saw things not described by Cuvier or dreamed of by Valenciennes.

The books call these fishes "Darters," from *Boleosoma* (*dart body*, in Greek), the name of the common eastern species; the realistic dwellers of the Ohio Valley call some of them hog-fishes; the boys call them Johnnies, and, as the boy instinct is the truest, Johnny Darters they shall be.

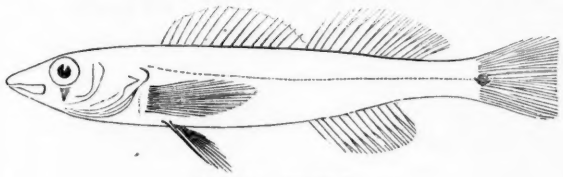
All the darters are very small fishes; the largest barely reaches the minimum of size on the urchin's string when he comes back from the mill-pond, while the smallest is with one or two exceptions the least of all fishes. They have only the rudiment of an air bladder, and are therefore unable to float freely in the water or even to swim at all without severe manual — not caudal — labor. They rest quietly on the bottom for the most part, curled up under a stone or standing on their front and tail fins; now and then throwing themselves forward for a short distance by a broad and sudden sweep of the pectorals, to snap at some water-bug or to dodge the claws of some crawfish or the grasp of some small boy. This movement made, they come to rest, either permanently or until they can bring their arms forward again. When a darter wishes to swim for any distance his course is peculiar: at every impulse forward he rises in the water; at every rest he begins to fall, his face meanwhile wearing an expression of contented helplessness. The whole movement is much like that of a boy learning to swim, whose nose goes under when he brings his arms forward after each stroke.

The mouth of the darter bristles with teeth, which indicate its carnivorous habits, and its great voracity makes it in a small way the terror of the aquarium, for it carries death and dismay to timid water-snails and the smaller crustaceans. It pounces upon a piece of meat with all the ferocity of a wild-cat, having none of the timid eagerness characterizing the minnows, and little of the graceful dash of the perch and bass.

Rafinesque says of the Johnnies of his acquaintance, "They are good to eat, fried." This is doubtless true, but I should as

soon think of filling my pan with wood-warblers. The good man goes a-fishing not for "pot-luck," but to let escape "the Indian within him."

Their small size, brilliant coloration, quaintness, and hardiness render the darters very desirable aquarium fishes, much more attractive in every respect than the cheap and vulgar gold-fish. They are little known even to naturalists; few of them have ever been figured, and the biography of none ever written, so we hope that this attempt to tell the story of some that we know may not be unattractive to those who can see something more in a little fish than a possible dinner to themselves or to a king-fisher.



(Fig. 22.) PERCINA.

The barred darter or log perch (*Percina caprodes;* Figure 22 represents a species of Percina) is the largest of the Etheostomoids. It may be most readily known by its superior size and by its peculiar pattern of coloration. The ground color is pale olive, darker above, silvery beneath; on this are about fifteen black vertical bars or incomplete rings, alternating more or less perfectly with as many shorter ones, which reach only half-way down or to the lateral line; the hindmost bar is reduced to a mere spot at the base of the caudal, and there are many black specks and mottlings on the fins. The body is long and slender, nearly cylindrical, and firm and wiry to the touch; the dorsal fins are large, and the first consists of about thirteen spines; the head is flat on top and tapers into a flat, pointed snout, which is abruptly squared off at the end, much overlapping the small mouth, after the fashion of the pig. The lateral line, as in all the species mentioned in this article, is perfectly distinct from the head to the tail.

Percina reaches a length of six or eight inches, and it may be readily caught with a hook baited with a worm. I often meet an urchin with one or two of them strung through the gills on a forked stick, along with "red eyes," "stone toters," and other "boys' fish." At such times, I generally buy the log perch for a cent, cut it open to look at the air bladder which the books

say it does not have, and then lay it away with the rest of my treasures in the bottle of alcohol.

We find Percina usually in rapid and rather deep water, as deep as we dare wade in when seining in hip boots. We rarely find them small enough for ordinary aquarium purposes, and the living specimen before me, though wonderfully quick and graceful, has shown little that is noteworthy, save his courage, love of angleworms, and a possible disposition to bury himself in the sand. There is something in the expression of his face, as he rests on his "hands and feet" on a stone, remarkably lizard-like, reminding me of the blue-tailed skink (*Eumeces fasciatus*).

We next come to the fine gentleman of the family, the black-sided darter (*Etheostoma blennioides*). This species may be known best by its coloration. The ground hue is a salmon yellow; the back is regularly and beautifully marbled with black, forming a peculiar and handsome pattern. On the sides, from the head to the tail runs a jet-black band which is widened at irregular intervals into round spots, which contrast sharply with the silvery color of the belly. Or we might say that on each side is a chain of confluent, round, black blotches. At times these spots are quite pale and do not seem to meet, but in an instant they regain their original form and shade. These changes are when the fish is excited by the presence of things eatable. A male in our aquarium underwent almost in an instant an entire change of pattern upon the introduction of a female fish of the same species, whom he recognized as his true affinity. Although the two have been together for some weeks, the novelty has not yet worn off, and though his colors vary much from one hour to another, he has never quite reverted to his original dress.

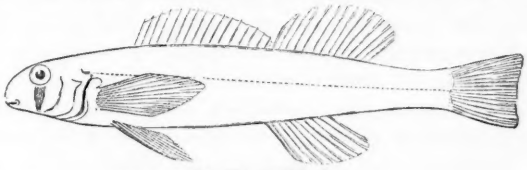
The form of the black-sided darter is more graceful than that of any other, and his movements have less of the angular jerkiness which distinguishes his relatives.

The dorsal fins, as in Percina, are long and large, the number of spines being about fourteen. Etheostoma delights in clear running water, and he may be found in most streams south and west of New York. A notable peculiarity is the presence of a row of shields or enlarged scales along the middle line of the belly. These may serve to protect that part from the friction of the stony bottom. They seem to be shed at some seasons, but when and why is unknown.

Etheostoma is especially desirable for aquaria. He is hardier than any other fish as pretty, and prettier than any other as

hardy, and withal he "has a way of his own," as Barney Mullins said of Thoreau.

The most simply beautiful of all fresh-water fishes is the green-sided darter (*Diplesium blennioides;* Figure 23 represents a



(Fig. 22.) DIPLESIUM.

species of this genus). He is not, like the Pœcilichthys, an animated rainbow, but has the beauty of green grass, wild violets, or a log covered with green moss. As we watch him in the water, with his bright, blended colors and gentle ways, once more, with Izaak Walton's Angler, "We sit on cowslip banks, hear the birds sing, and possess ourselves in as much quietness as the silent, silver streams which we see glide so quietly by us."

During the ordinary business of the year the Diplesium, like most sensible fishes and men, dresses plainly. It is a serious matter to get any time for contemplation when the streams are low and food scarce, and a plain coat may ward off danger as well as facilitate attack. At all times, however, he may be known by these marks: the fins are all large, and the first dorsal has thirteen spines; the back is covered with zigzag markings down to the lateral line, which is complete and continuous, while below it extend eight or nine arrow-shaped, olive spots, which are more or less connected above, sometimes as if forming a wavy line; these are on a nearly white ground, which blends with the uniform coloration of the belly. The eyes are quite large and prominent, the snout is short and rounded, giving a decidedly frog-like profile, while on a front view the little, inferior mouth seems puckered with "prunes and prisms." The roof of the mouth is toothless, though all the other Johnnies have small teeth on the front part of the roof behind the jaws, the region technically known as the vomer.

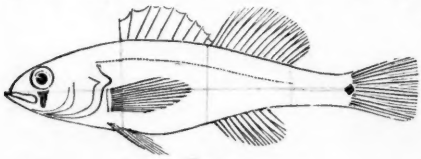
But when the first bluebirds give warning by their shivering and bodiless notes that spring is coming, then the Diplesium puts on his wedding clothes and becomes in fact the green-sided darter. The dorsal fins become bright grass-green, with a scarlet band at the base; the broad anal has a tinge of the deepest emerald, while every spot and line upon the side has turned from

an undefined olive to a deep, rich green, scarcely found elsewhere in the animal world except on the backs of frogs.

The same tint flashes out on the branching rays of the caudal fin, and may be faintly seen struggling through the white on the belly. The blotches nearest the middle of the back become jet-black, and thickly sprinkled everywhere are little shiny spots of a clear, bronze orange. In the aquarium, Diplesium seems more shy and retiring, too much of a fine lady to scramble for angle-worms or to snap at the "bass-feed." She is usually hidden among the plants, or curled up under an arch of stones or in a geode. Specimens may be caught most abundantly in rapid, gravelly streams, but we often find stray individuals lying on sandy bottoms, the proper home of the Pleurolepis.

Boleosoma effulgens[1] is the darter of darters. Although our earliest aquarium friend, for the very first specimen placed there showed us by a rapid ascent of the river-weed how "a Johnny could climb trees," he has still many resources which we have never learned. Whenever we try to catch one with the hand we begin with all the uncertainty which characterized our first attempt, even if we have him in a two-quart pail.

He may be known from his cousins by his short first dorsal fin of nine spines, and by the absence of all color save soft brown on white that has the faintest tinge of yellow, but not a dirty white at all. The other nine-spined darters, Pœcilichthys, etc. (Figure 24 represents a species of this genus), have a different mouth, a projecting lower jaw,[2] the body deeper, and the lateral line vanishing on the back of the body. The brown on the sides of Boleosoma is arranged in seven or eight W-shaped marks, below which are a few flecks of the same color. Covering the sides above the lateral line are wavy markings, — gathered into blotches on the



(Fig. 24.) PŒCILICHTHYS.

[1] *Boleosoma effulgens* is the common species in the neighborhood of Indianapolis, to which latitude all the accounts here given must be referred. Eastward occurs *Boleosoma olmstedi*, which is somewhat larger and has the cheeks thickly scaly. We are not quite sure that the change of color in Diplesium depends on the season, but our observations thus far indicate it.

[2] Not as represented in the figure, in which the body is also represented too deep. The cuts accompanying this article are outlines only and erroneous in many of the details. While of much value as giving a general idea of the Etheostomoids, nevertheless the authors disclaim any responsibility for them.

median line, — that have given him the name of tesselated darter, said by the books to be "common." But Boleosoma is a braver name, and we even prefer "Boly," for short. The head resembles that of Diplesium, but the habit of leaning forward over a stone, resting on the front fins, gives a physiognomy even more frog-like; his actions however, are, rather bird-like, for he will strike attitudes like a tufted titmouse, and he flies rather than swims through the water. He will with much perseverance push his body between a plant and the side of the aquarium, and balance himself on the slender stem. Crouching cat-like before a snail-shell, he will snap off the horns which the unlucky owner pushes timidly out. But he is often less dainty, and, seizing the animal by the head, dashes the shell against the glass or a stone until he pulls the body out or breaks the shell. "Boly," alas! is the "Quaker of our aquarium" only in appearance.

THE BLACK KNOT.

THE following article is an abstract, by Mr. B. D. Halsted, of a paper by Prof. W. G. Farlow published in the Bulletin of the Bussey Institution of March, 1876. It will be the endeavor to give, with the aid of two of the three original plates,[1] a brief notice of the most important points concerning this destructive fungus.

Without doubt, the most striking disease of vegetable origin occurring on fruit-trees in this country is that commonly known as the black knot. The disease takes its name from the unsightly, black, wart-like excrescences, with which every one is familiar, on plum-trees and different kinds of wild and cultivated cherries. It is found in all parts of our country east of the Rocky Mountains, and is so common and destructive that in some districts one seldom sees a plum-tree free from the knot. An idea may be formed of the small crop of plums now raised in New England from the fact that two dollars and a half were given in Boston last autumn for a peck of damsons for preserving. In some parts of New England, particularly in Maine and along the sea-coast, the raising of cherries has also been almost aban-

[1] The sum of $500 was voted by the Trustees of the Massachusetts Society for Promoting Agriculture to aid Professor Farlow in his researches, and from this liberal appropriation the expense of the plates was defrayed. Professor Farlow is himself responsible for the microscopic details of the plates, but whatever of beauty they may possess is entirely due to the skill of Mr. J. H. Blake, of the Museum of Comparative Zoölogy, Cambridge.

doned, in consequence of the ravages of the black knot. The disease is peculiar to America, and has been the bane of fruit-growers from early times; but although much has been written in agricultural papers about its injury to the fruit crop, the subject has been almost entirely neglected by botanists. In the present paper we shall consider the cause and prevention of the knot, and the question whether the disease is the same on plums and cherries. As a preliminary step, it will be well to trace the development of the knot as it occurs on a single species, and for this purpose the choke-cherry, *Prunus Virginiana* L., may be selected.

The size of the knots varies greatly, being found on the species of *Prunus* under consideration all the way from a few lines to several inches in length, with an average of two inches in circumference. The knot does not usually entirely surround the branch, but growing from one side, often causes the branch to bend or twist into an irregular shape. In the winter, when the branches are leafless, the knots are much more noticeable, and at this season they are often cracked and broken, worm-eaten and hollow.

In the swollen portions of the branch above and below the knot, sections under the microscope show the vegetative portion of the fungus in the form of minute threads, .0007 mm. in diameter, twisted together and extending from the cambium towards the outer portion of the stem, where they become separated as shown in Plate IV., Figure 1. The fungus first reaches the cambium either by the germination of spores on the surface of the branch, or by the mycelium proceeding from a neighboring knot. The part of the cambium free from these bundles of mycelial threads grows in the usual manner, and in an old branch a cross section shows at the end of the season one more "ring" or layer of wood on the sound than on the diseased side. From this it is to be concluded that the growing layer of tissue of the plum or cherry branch is the place from which the fungus begins its destructive work.

In the spring the swollen portion of the branch, whether it be on either side of an old knot or at the beginning of a new one, increases in size, and the mycelium soon reaches and bursts through the bark, so that by the time the choke-cherry is in flower the knot has reached nearly its full size, though differing from an old one in being still greenish in color and solid or pulpy in consistency.

"With a hand-lens one can see small hemispherical protuberances, which are the beginnings of the 'perithecia.' The whole surface of the protuberances is covered with filaments (Plate III., Figure 2) about .04 mm. to .06 mm. in height and .004 mm. in breadth, which are somewhat flexuous and frequently divided by cross-partitions. The filaments are more frequently simple, but sometimes branch. At the tip of the terminal joint, or more frequently a little to one side, is borne a spore .006 mm. in length, ovate and rather sharply pointed at the lower end. Not unfrequently two or three spores are borne on the upper joint, and others may also be produced on some of the lower joints. We have never seen any cross divisions in the conidial spores, which fall very early from their attachments. The conidia which we have just described spring directly from the surface of the perithecia. They continue to bear their spores until the latter part of summer, when they begin to dry up, and as winter sets in one finds only their shriveled remains." As autumn approaches, the knots assume their black color, the inner portions being either destroyed by insects or reduced to a powdery mass, with only the hard outer shell, which contains the perithecia, left in place. These perithecia are small pits or sacs which are scattered through the hard crust and contain the sexual spores, borne, always to the number of eight, in asci or cells. In Plate IV., Figure 4, is shown a highly magnified cross section through a perithecium, with the spore sacs attached to the wall. Figure 3 of the same plate gives a still more magnified view of two of the asci, with the spores somewhat regularly disposed; while springing from the wall of the perithecium and extending above the asci are the long and slender sterile threads called "paraphyses."

"The asci grow slowly during the winter, and about the middle of January the spores begin to ripen. In the month of February they are found in perfection; but late in spring they are not so abundant or in such good condition. We first found a few ripe spores on the 17th of January; and in the second week of February, most of the knots examined contained ripe spores. . . . . The spores measure from .016 mm. to .02 mm. in length and from .008 mm. to .01 mm. in breadth. They are two-parted, as shown in Plate IV., Figures 5 and 6; one division being uniformly much smaller than the other, and not more than one quarter or one third as long. The spores are transparent and slightly granular. As they lie in the ascus, the small end almost invariably points downwards. Spores which ripen in February

germinate in the course of from three to five days, when sufficiently moist."

Besides the conidial spores formed from the outside, and the ascospores from the inside, of the wall of the perithecia, there are still other forms of fruit, which are called stylospores. These spores are produced in cavities between the perithecia; a cross section of such a cavity is represented in Plate III., Figure 4, with a small portion more magnified in Figure 5, showing these bodies to be borne on long stalks and divided by partitions into four parts.

"Plate IV., Figure 2, represents a section through a cavity hardly distinguishable externally from the perithecia, which, instead of being filled with asci, is lined with slender filaments whose tips are somewhat incurved, and easily broken off, the central part of the sac being filled with them. We call these "spermogonia," from their resemblance to the bodies of the same name in lichens. They are much less common than the conidia or stylospores. Interspersed amongst the ascus-bearing perithecia, one finds tolerably frequently still other cavities which are much more flattened than the perithecia, which often, instead of appearing oval, on section seem almost triangular. They are lined with short, delicate filaments which end in a minute oval hyaline body. These small oval bodies are produced in immense numbers, and are discharged not singly, but in masses. They are more or less closely held together by a sort of jelly, and ooze out from the cavity in which they are produced in the form of tendrils reminding one of the toy called "Pharaoh's serpent." This last form is called the "pycnidia." It seems that this fungus does not lack for methods of propagating itself and continuing its species.

The knot on the choke-cherry, when compared with those on the plum and cultivated varieties of cherry, is seen to be slightly different in general appearance; but when viewed with the microscope they all prove to be identical, the difference noticeable to the naked eye being due to more favorable circumstances for its growth afforded by one species of *Prunus* than by another. On the plum it does not thrive as well as on the choke-cherry. The curculio deposits its eggs in the young pulpy knot, and from the punctures a gum soon exudes and on this coating a mold, *Trichothecium roseum* Lk., quickly develops, giving a peculiar pinkish color to the knot. "It is probably owing to the fact that the curculio stings the knots that so many persons have been led to believe that the knots themselves are of insect origin."

Schweinitz was the first to describe, under the name of *Sphæria morbosa*, the fungus causing the black knot. At that time nothing was known of the secondary forms of fruit of this group of fungi. Mr. C. H. Peck was the first to describe the conidia.

From a short discussion as to the position this species should take in classification and the name it ought to bear, it is concluded that until its related species are better known its old place and name had best be retained.

The black knot is far from being of recent origin, and has furnished a subject about which vastly more has been written than was known. Many, especially the early writers, held it to be of insect origin, while, later, others have looked upon it as a vegetable growth, and still others included in its production the actions of both these forms of life. During the last thirty years the insect theory has been gradually given up by the entomologists; but it still remains for many fruit-growers to accept the knot as being of fungus origin. The proof given in the paper is very conclusive on this long-disputed point. "First, the knots do not resemble the galls made by any known insect. Secondly, although insects, or remains of insects, are generally found in old knots, in most cases no insects at all are found in them when young. Thirdly, the insects that have been found by entomologists in the knots are not all of one species, but of several different species, which are also found on trees which are never affected by the knot. On the other hand, we never have the black knot without the *Sphæria morbosa*, as was admitted by Harris; and the mycelium of that fungus is found in the slightly swollen stem long before anything which could be called a knot has made its appearance. Furthermore, the *Sphæria morbosa* is not known to occur anywhere except in connection with the knots."

Those who believe that there are two distinct species of the knot have arrived at this conclusion from a too hasty generalization upon incomplete observations. "Having seen some cherries free from the knot, although growing near diseased plum-trees, and others, perhaps not near any plum-trees, covered with knots, they have jumped at the conclusion that there must be two different fungi producing the knot: one on the cherry, derived from the wild cherry; another on the plum, derived from the wild plum." This false inference comes from the fact that some species of wild cherry, and also some cultivated varieties, are not attacked by the knot. "*Prunus serotina* Ehr., the rum-cherry,

and *Prunus Virginiana* L., the choke-cherry, are about equally common near Boston. The latter is very frequently attacked by the knot; the former never, as far as our experience goes, and we have examined hundreds of trees." In and around Boston the cultivated plum has been nearly destroyed by the knot, while over the same territory the wild plum is of rare occurrence, if found at all, showing that the disease must come from some species of cherry.

In all this long discussion of the black knot much confusion has grown out of the loose use of popular names. The choke-cherry of one person may not be the choke-cherry of another; and the bird or rum cherry in one section may bear other names in another part of the country.

With a knowledge of the nature of this contagious disease the remedy at once suggests itself: namely, to cut off the knots, together with the swollen portions of the branches, wherever and whenever they are found. In autumn, as soon as the leaves fall, the knots can be most easily seen, and all branches bearing them should be taken off and burned at once. Though the ascospores are not formed until late in the following winter, it was carefully observed that, were the knots left undestroyed, they would ripen after the branch was cut from the tree. The choke-cherry, bird-cherry, and wild plum furnish means for rapid propagation of the knot, and they should be gladly sacrificed for the good of their more worthy allies. Of the choke-cherry the writer says, "However opinions may differ as to its beauty, there can be only one as to its injurious influence on cherry and plum orchards; and it cannot be too strongly impressed upon fruit-growers that the choke-cherry is a most dangerous enemy, and should be destroyed."

Knowing the cause, nature, and means of propagation of the black knot, it remains for the fruit-growers to profit by their valuable instruction and use their best endeavors to destroy this pest. The article closes with a statement of the importance of keeping the disease within its present bounds. It is now peculiar to America, and any means of introducing it into other countries should be strenuously avoided.

EXPLANATION OF THE PLATES.

Plate III. Figure 1. *Sphæria morbosa* on the cultivated plum, as seen in autumn, natural size.

Figure 2. Section of knot on the choke-cherry in May, magnified six hundred diameters; *a*, mycelium; *b*, conidia.

Figure 3. Conidia more highly magnified.

Figure 4. Section through one side of a cavity containing stylospores. From mazzard cherry.

Figure 5. Stylospores more highly magnified.

Plate IV. Figure 1. Section of choke-cherry stem, showing the mycelium before it has come to the surface, magnified six hundred diameters.

Figure 2. Spermogonia.

Figure 3. Asci and spores of *Sphæria morbosa* from the choke-cherry.

Figure 4. Perithecium with asci.

Figures 5, 6. Ripe ascospores.

Figures 7, 8. Ascospores germinating.

PROFESSOR TYNDALL ON GERMS.

UNDER this head, *Nature* gives an abstract of a paper read by Professor Tyndall before the Royal Society, January 13th, entitled On the Optical Deportment of the Atmosphere in Reference to the Phenomena of Putrefaction and Infection. Among other things, he wished to free his mind, and if possible the minds of others, from the uncertainty and confusion which now beset the doctrine of "spontaneous generation." Pasteur has pronounced it "a chimera," and expressed the undoubting conviction that, this being the case, it is possible to remove parasitic diseases from the earth. We make a few extracts from this interesting article: —

"To the medical profession, therefore, and through them to humanity at large, this question is one of the last importance. But the state of medical opinion regarding it is not satisfactory. In a recent number of the *British Medical Journal*, and in answer to the question, 'In what way is contagium generated and communicated?' Messrs. Braidwood and Vacher reply that notwithstanding 'an almost incalculable amount of patient labor, the actual results obtained, especially as regards the manner of generation of contagium, have been most disappointing. Observers are even yet at variance whether these minute particles, whose discovery we have just noticed, and other disease germs, are always produced from like bodies previously existing, or whether they do not, under certain favorable conditions, spring into existence *de novo*.' . . .

"The result of the experiments showed that infusions of various substances exposed to the common air of the Royal Institution laboratory, maintained at a temperature of from 60° to 70° Fahr., all fell into putrefaction in the course of from two to four

days. No matter where the infusions were placed, they were infallibly smitten. The number of the tubes containing the infusions was multiplied till it reached six hundred, but not one of them escaped infection.

"In no single instance, on the other hand, did the air, which had been proved moteless by the searching beam, show itself to possess the least power of producing bacterial life or the associated phenomena of putrefaction. The power of developing such life in atmospheric air, and the power of scattering light, are thus proved to be indissolubly united.

"The sole condition necessary to cause these long-dormant infusions to swarm with active life is the access of the floating matter of the air. After having remained for four months as pellucid as distilled water, the opening of the back door of the protecting case, and the consequent admission of the mote-laden air, suffice in three days to render the infusions putrid and full of life. . . .

"From the irregular manner in which the tubes are attacked, we may infer that, as regards *quantity*, the distribution of the germs in the air is not uniform. The singling out, moreover, of one tube of the hundred by the particular *bacteria* that develop a green pigment, shows that, as regards *quality*, the distribution is not uniform. The same absence of uniformity was manifested in the struggle for existence between the *bacteria* and the penicillium. In some tubes the former were triumphant; in other tubes of the same infusion the latter was triumphant. It would seem also as if a want of uniformity as regards *vital vigor* prevailed. With the self-same infusion the motions of the *bacteria* in some tubes were exceedingly languid, while in other tubes the motions resembled a rain of projectiles, being so rapid and violent as to be followed with difficulty by the eye. Reflecting on the whole of this, the author concludes that the germs float through the atmosphere in groups or clouds, with spaces more sparsely filled between them. The touching of a nutritive fluid by a bacterial cloud would naturally have a different effect from the touching of it by the interspace between two clouds. But as, in the case of a mottled sky, the various portions of the landscape are successively visited by shade, so, in the long run, are the various tubes of our tray touched by the bacterial clouds, the final fertilization or infection of them all being the consequence. The author connects these results with the experiments

of Pasteur on the non-continuity of the cause of so-called spontaneous generation, and with other experiments of his own.[1]

"On the 9th of November, a second tray, containing one hundred tubes filled with an infusion of mutton, was exposed to the air. On the morning of the 11th, six of the ten nearest the stove had given way to putrefaction. Three of the rows most distant from the stove had yielded, while here and there over the tray particular tubes were singled out and smitten by the infection. Of the whole tray of one hundred tubes, twenty-seven were either muddy or cloudy on the 11th. Thus, doubtless, in a contagious atmosphere are individuals successively struck down. On the 12th, all the tubes had given way, but the differences in their contents were extraordinary. All of them contained *bacteria*, some few, others in swarms. In some tubes they were slow and sickly in their motions, in some apparently dead, while in others they darted about with rampant vigor. These differences are to be referred to changes in the germinal matter, for the same infusion was presented everywhere to the air. Here also we have a picture of what occurs during an epidemic, the difference in number and energy of the bacterial swarms resembling the varying intensity of the disease. It becomes obvious from these experiments that of two individuals of the same population, exposed to a contagious atmosphere, the one may be severely, the other lightly attacked, though the two individuals may be as identical, as regards susceptibility, as two samples of one and the same mutton infusion.

"The author traces still further the parallelism of these actions with the progress of infectious disease. The *Times* of January 17th contained a remarkable letter on Typhoid Fever, signed 'M. D.,' in which occurs the following remarkable statement: 'In one part of it (Edinburgh), congregated together and inhabited by the lowest of the population, there are, according to the corporation return for 1874, no less than 14,319 houses or dwellings — many under one roof, on the "flat" system — in

[1] In hospital practice, the opening of a wound during the passage of a bacterial cloud would have an effect very different from the opening of it in the interspace between two clouds. Certain caprices in the behavior of dressed wounds may possibly be accounted for in this way. Under the heading Nothing new under the Sun, Professor Huxley has just sent me the following remarkable extract: "Uebrigens kann man sich die in der Atmosphäre schwimmenden Thierchen wie Wolken denken, mit denen ganz leere Luftmassen, ja ganze Tage völlig reinen Luftverhältnisse wechseln." (Ehrenberg, Infusions Thierchen, 1838, p. 525.) The coincidence of phraseology is surprising, for I knew nothing of Ehrenberg's conception. My "clouds," however, are but small miniatures of his.

which there are no house connections whatever with the street sewers, and consequently no water-closets. To this day, therefore, all the excrementitious and other refuse of the inhabitants is collected in pails or pans, and remains in their midst generally in a partitioned-off corner of the living-room until the next day, when it is taken down to the streets and emptied into the corporation carts. Drunken and vicious though the population be, herded together like sheep, and with the filth collected and kept for twenty-four hours in their very midst, it is a remarkable fact that typhoid fever and diphtheria are simply unknown in these wretched hovels.'

"This case has its analogue in the following experiment, which is representative of a class. On November 30th a quantity of animal refuse, embracing beef, fish, rabbit, hare, was placed in two large test-tubes opening into a protecting chamber containing six tubes. On December 13th, when the refuse was in a state of noisome putrefaction, infusions of whiting, turnip, beef, and mutton were placed in the other four tubes. They were boiled and abandoned to the action of the foul "sewer gas" emitted by their two putrid companions. On Christmas Day the four infusions were limpid. The end of the pipette was then dipped into one of the putrid tubes, and a quantity of matter comparable in smallness to the pock-lymph held on the point of a lancet was transferred to the turnip. Its clearness was not sensibly affected at the time; but on the 26th it was turbid throughout. On the 27th, a speck from the infected turnip was transferred to the whiting; on the 28th, disease had taken entire possession of the whiting. To the present hour the beef and mutton tubes remain as limpid as distilled water. Just as in the case of the living men and women in Edinburgh, no amount of fetid gas had the power of propagating the plague as long as the organisms which constitute the true contagium did not gain access to the infusions.

"The universal prevalence of the germinal matter of *bacteria* in water has been demonstrated with the utmost evidence by the experiments of Dr. Burdon Sanderson. But the germs in water are in a very different condition, as regards readiness for development, from those in air. In water they are thoroughly wetted and ready, under the proper conditions, to pass rapidly into the finished organism. In air they are more or less desiccated, and require a period of preparation more or less long to bring them up to the starting-point of the water-germs. The rapidity of

development in an infusion, infected by either a speck of liquid containing *bacteria* or a drop of water, is extraordinary. On January 4th a thread of glass almost as fine as a hair was dipped into a cloudy turnip infusion, and the tip only of the glass fibre was introduced into a large test-tube containing an infusion of red mullet. Twelve hours subsequently, the perfectly pellucid liquid was cloudy throughout. A second test-tube containing the same infusion was infected with a single drop of the distilled water furnished by Messrs. Hopkin and Williams; twelve hours also sufficed to cloud the infusion thus treated. Precisely the same experiments were made with herring, with the same result. At this season of the year, several days' exposure to the air are needed to produce so great an effect. On December 31st a strong turnip-infusion was prepared by digesting thin slices in distilled water at a temperature of 120° Fahr. The infusion was divided between four large test-tubes, in one of which it was left unboiled, in another boiled for five minutes, in the two remaining ones boiled and, after cooling, infected with one drop of beef-infusion containing *bacteria*. In twenty-four hours the unboiled tube and the two infected ones were cloudy, the unboiled tube being the most turbid of the three. The infusion here was peculiarly limpid after digestion; for turnip it was quite exceptional, and no amount of searching with the microscope could reveal in it at first the trace of a living bacterium; still germs were there which, suitably nourished, passed in a single day into bacterial swarms without number. Five days have not sufficed to produce an effect approximately equal to this in the boiled tube, which was uninfected, but exposed to the common laboratory air.

"There cannot, moreover, be a doubt that the germs in the air differ widely among themselves as regards *preparedness* for development. Some are fresh, others old; some are dry, others moist. Infected by such germs, the same infusion would require different lengths of time to develop bacterial life. This remark applies to and explains the different degrees of rapidity with which epidemic disease acts upon different people. In some, the hatching period, if it may be called such, is long, in some short, the differences depending upon the different degrees of preparedness of the contagium."

ON THE FORMER CLIMATE OF THE POLAR REGIONS.[1]

BY PROFESSOR A. E. NORDENSKIÖLD.

ONLY a few years ago it was looked upon as an article of faith among geologists that the whole globe was once in a melted, incandescent state, and that the conditions of temperature now prevailing on the surface of the earth have been in process of time produced by the slow, gradual cooling of the once fused and glowing mass. It then appeared so natural that, in consequence of the earth's internal heat, a tropical climate should extend from pole to pole, that no special weight was attached to the evidences of this fact which geology was at that time able to produce. The Dane Giesecke's and the English Scoresby's specimens of fossil plants from the east and west coasts of Greenland, evidencing a warm climate there, attracted so little attention that neither they, nor the fossil remains of Saurians found by the famous Arctic traveler, Sir Edward Belcher, in the American Polar Archipelago, could be found in the museums to which they had been confided.

It was not till geologists had become fully convinced that the gradual transition from the time when a warm climate was supposed to have prevailed over the whole earth and the present time has at least once been interrupted by a period during which the greater part of the European and American continents were covered by mighty glaciers, that the geological theory of climates was taken up with real interest. People began gradually to perceive that, even supposing the earth really to have once been in a state of glowing fusion, the cooling must already at the Cambrian and Silurian epochs have proceeded so far that the quantity of heat which the earth lost by radiation was fully compensated by that which it received from the other heavenly bodies. It has also been supposed that the cause of the glacial period — when vast ice mountains scattered bowlders from Scandinavia over the plains of Northern Germany, and when the Swiss Alps formed the centre of an icy desert similar to the present Greenland — is to be sought for in some trifling changes in the form of the earth's orbit and the inclination of the equator, which have taken place and continue to take place periodically after the lapse of thousands or hundreds of thousands of years. The same causes which have once produced the glacial period have thus happened, not only during this last period nearer to our own

[1] A lecture delivered at the anniversary meeting of the Royal Swedish Academy of Science, March 31, 1875, and translated for The Geological Magazine.

time, but also many times before; and there is reason to suppose that they were also then followed by somewhat similar results, — that is to say, that the cold and the warm eras have many times alternated on the surface of the earth. In consequence of this, it has become a matter of the utmost importance to science to obtain by real observation accurate information as to the state of temperature on the earth's surface during as many of the different geological periods as possible. When in our days a scientific question is seriously propounded, it is seldom long before it is answered; and even in the instance before us we have of late years received numerous contributions to geological climatology from lands the geographical situation of which, in the neighborhood of the pole, renders them best fitted to yield information of this kind.

The geology of the polar tracts can in two different ways supply us with information concerning the former climate, partly by a comparison of the fossil animals and plants there found with existing forms that live under certain determinate climatic conditions, partly by an accurate examination of the various strata of different geological ages, with a view to ascertain whether these present any of the indications which usually distinguish glacial formations.

We now possess fossil remains from the polar regions belonging to almost all the periods into which the geologist has divided the history of the earth. The Silurian fossils which McClintock brought home from the American Polar Archipelago, and the German naturalists from Novaja Semlja, as also some probably Devonian remains of fish found by the Swedish expeditions on the coasts of Spitzbergen, are, however, too few in number, and belong to forms too far removed from those now living, to furnish any sure information relative to the climate in which they have lived.

Immediately after the termination of the Devonian age, an extensive continent seems to have been formed in the polar basin north of Europe, and we still find in Beeren Island and Spitzbergen vast strata of slate, sandstone, and coal, belonging to that period, in which are imbedded abundant remains of a luxuriant vegetation, which, as well as several of the fossil plant-remains brought from the polar regions by the Swedish expeditions, have been examined and described by Professor Heer, of Zürich. We here certainly meet with forms, vast *Sigillaria*, *Calamites*, and species of *Lepidodendron*, etc., which have no exactly correspond-

ing representatives in the plants now existing. Colossal and luxuriant forms of vegetation, however, indicate a climate highly favorable to vegetable development. A careful examination of the petrifactions taken from these strata shows also so accurate an agreement with the fossil plants of the same period found in many parts of the continent of Central Europe, that we are obliged to conclude that at that time no appreciable difference of climate existed on the face of the earth, but that a uniform climate extremely favorable for vegetation — but not on that account necessarily tropical — prevailed from the equator to the poles.

The sand and slate beds here mentioned do not contain any marine petrifactions, whence we may conclude that they have been formed in lakes or other hollows in an extensive polar continent. In Beeren Island and Spitzbergen they are, however, covered by beds of limestone and siliceous rock, which form the chief material in Beeren Island, and of several considerable mountains on the southern side of Hinloopen Strait, and the innermost bays of Ice-fjord in Spitzbergen. The manner in which these mountains rise several thousand feet above the surrounding snow desert, their regular form, crowned with vast masses of dark volcanic rock divided into vertical columns, the siliceous strata forming perpendicularly-scarped terraces, and the tendency of the calcareous beds to fall away and form natural arches, give to these mountains the appearance of ruins of colossal ancient fortifications and temples, unequaled in sublime and desolate magnificence. Here, indeed, we meet with the monumental gravestones of a long-past age. The rock is in fact formed almost entirely of shells of marine mollusca, fragments of corals, and bryozoa of the age of the mountain-limestone. We have then, here, not only a proof that the ancient polar continent sank down again and gave place to a deep polar ocean, but also, in the correspondence of the corals, shells, and other associated organic remains with those met with in more southerly tracts, an indication that the warm polar climate remained unchanged.

The mountain-limestone period was followed by an era during which the richest coal-beds of England, Belgium, and America were formed, and which has accordingly received the name of the coal period. A new distribution of land and water had now taken place, continents had again arisen in the polar tracts, in the sandstones and argillaceous strata of which we again find, at Bell Sound, on the western coast of Spitzbergen, fossil plants

that bear witness to a rich polar vegetation developed under a warm climate. Among these, however, we miss the species of large-leaved fern so abundant in the coal-beds of more southerly lands, a circumstance which may possibly indicate a certain difference of climate as existing at that epoch, unless, as is more probable, the circumstance is merely the result of the insufficiency of the materials brought from but one single arctic locality.

The only relics from the polar regions belonging to the succeeding era, the Triassic, are those of marine animals, amongst which a considerable portion consists of large, shell-clad Cephalopoda related to Ammonites, Nautilus, etc., which, judging from the habits of the forms still existing in our time, could assuredly have only lived in a warm ocean. More certain information relative to the nature of the polar climate at that time is afforded by portions of skeletons of colossal Sauria, — one form, *Ichthyosaurus polaris*, seems to have reached a length of twenty or thirty feet, — which, together with vast coprolite beds, are found in great abundance inclosed in the Triassic strata of Ice-fjord, and which among the now existing fauna have their nearest representatives in the crocodiles on the sunny banks of the Nile, or perhaps rather in the marine lizard, *Amblyrhynchus*, met with in the Galapagos Isles. That multitudes of these cold-blooded animals lived at that time in the vicinity of the eightieth degree of latitude attests beyond all doubt climatal conditions very different from those of the present day.

At the entrance of Ice-fjord and at Mount Agardh, in Storfjord, the Triassic strata are covered with marine formations belonging to the immediately subsequent geological era, the Jura period, and, as far as we can judge from the few fossil remains hitherto discovered in these strata, no diminution had as yet taken place in the warmth of the polar climate. But great changes now came to pass in the portion of the polar basin north of Europe, the ocean being again transformed into a continent, which, though shattered and reduced, still exists up to the present time. The upper portion, therefore, of the Jura formation of Spitzbergen does not contain any marine organisms, but in the place of them beds of sandstone and slate, with coal-seams and impressions of plants. From the strata belonging to that age met with at Cape Boheman, in Ice-fjord, situated between the seventy-eighth and seventy-ninth degrees of latitude, the Swedish expeditions have brought home numerous impressions of

palm-like cycadeæ and coniferæ, the representative species of which now flourish in the neighborhood of the tropics. This already leads to the supposition of a warm climate, which supposition is further confirmed by a comparison with the European fossil flora of the same date, which indicates that the climate of Spitzbergen did not then materially differ from that of Central Europe.

The Swedish expeditions have also succeeded in obtaining, partly from Greenland and partly from Spitzbergen, from two separate epochs of the Cretaceous era, extensive collections of fossil plants, lately described by Professor Heer in the Transactions of the Royal Swedish Academy. By this we have been enabled not only to determine the epoch when differences of climate first began to show themselves on the surface of the earth, but also pretty closely to follow an extremely remarkable change in the appearance of the vegetable world which took place during the course of that period.

Within the polar basin we meet with the lowest division of the Cretaceous age on the north side of the Noursoak peninsula, in Northwestern Greenland. The crown of the hills is here composed of black, ancient lava-streams and immense beds of volcanic tuff, hardened in process of time into solid rock.

Over these volcanic formations now rests a covering of perpetual ice, and beneath them on the sea-shore vast strata of sand are discovered, containing inconsiderable coal-beds, interstratified with clay-beds and a fine-grained argillaceous shale singularly fitted for preserving the impressions of fossils that have been imbedded in it. These plants belong to the lowest portion of the Cretaceous age, and among the collections brought from this spot, Heer has succeeded in distinguishing seventy-five different species, among which are thirty ferns, nine cycadeæ, and seventeen coniferæ.

The third part of the ferns belongs to one genus, *Gleichenia*, which still flourishes in the neigborhood of the tropics and warmer parts of the temperate zone, and the same remark holds good of the cycadeæ, most of which are referable to the genus *Zamia*, species of which we meet with within the tropics, as also of the coniferæ, some of which are nearly related to forms still existing in Florida, Japan, and California. From this Heer draws the conclusion, that in the early part of the Cretaceous period the climate of the now ice-covered Greenland was somewhat like that which now prevails in Egypt and the Canary Isles.

Among the ferns, cycadeæ, and coniferæ of Noursoak peninsula, were found a few impressions of a species of the poplar, *Populus primæva*, which formed the only and at the same time the oldest known representative of the forest vegetation now prevailing in the temperate zone. Nevertheless the vegetation of the arctic tracts was already during the Cretaceous period undergoing a complete transformation. Evidence of this has been obtained from the same locality, Atanekerdluk, on the south side of the Noursoak peninsula, from which such magnificent remains of arctic vegetation of the Tertiary period had previously been obtained, from strata at a somewhat higher level. Here, out of the talus that has fallen from the lofty fells, some black and tolerably easily crumbling strata of shale protrude, among which, on careful inspection, impressions of plants may be discovered belonging to the Cretaceous formation, not to the lower, but the upper portion of it. The vegetation is here quite different. The ferns and cycadeæ have disappeared, and in their place we find deciduous trees and other dicotyledons in astonishing variety and forms, among which a species of fig may be mentioned, of which not only the leaves, but also the fruit, have been obtained in a fossil state; two species of magnolia, etc. The climate that then prevailed over the whole globe was therefore still warm and luxuriant, even if, at least in the arctic regions, considerably modified from what it formerly had been, inasmuch as that the flowerless vegetation (which was now beginning to die out), as far as we can judge from its present representatives, the ferns, required a warm, humid climate, whereas the new forms with their luxuriant flowers, which now began to characterize the vegetable world, required, in order to develop all the grandeur of their colors, a clear and sunny sky. The disappearance of sundry tropical and sub-tropical forms that are met with in the older Cretaceous strata has led Heer to the conclusion that difference of climate at different latitudes was now beginning to show itself, and he calls attention to the circumstance that this takes place synchronously with the development of the dicotyledonous plants in greater variety.

Unhappily, in the arctic regions no fossil remains belonging to the Eocene age, which immediately succeeded the Cretaceous period, have hitherto been met with, and we are therefore destitute of the actual data necessary for ascertaining its climatic character. But the next following, or Miocene, age places at our disposal abundant materials in the magnificent remains of

plants obtained, we may say, from all parts of the polar basin and its vicinity: from West Greenland by Inglefield, McClintock, Rink, Torell, Whymper, and the Swedish expeditions; from East Greenland by Payer; from Alaska by Mr. Furnhjelm; from Sagalin by Admiral Furnhjelm; and from different localities of Spitzbergen by the Swedish expeditions.[1] The spots where remains of this period are found are frequently distinguished by their astonishing abundance of fossil plant-remains.

For example, at a place in Spitzbergen which we have called Cape Lyell, after the lately-deceased great English geologist, the rocks on the shore for a distance of several hundred feet form a continuous herbarium, where every stroke of the hammer brings to light an image of the vegetation of a long-past age, when the forest vegetation of these tracts consisted of the swamp-cypress of Texas (*Taxodium distichum*), of gigantic sequoias, relations or ancestors of California's mammoth tree, of large-leaved birches, limes, oaks, beeches, planes, and even magnolias. The place is situated in about 77° 35′ N. lat., on the south side of the entrance to Bell Sound, on the western coast of Spitzbergen. At the foot of the cliff, on one or two barren heaps of gravel, one may discover shoots an inch long of the polar willow, sole representative of the present vegetation of the locality. Just off the shore the ocean currents drive icebergs, which have fallen from the neighboring glaciers, backwards and forwards, and the crown of the rock itself forms the limit of a mighty glacier, which threatens within a few years to bury, under an icy covering of several hundred feet thickness, not only the little vegetation that exists here, and which in the summer weeks is sometimes adorned with charming colors, but also the memorials of the ancient glorious age now preserved within its rocks.

By a careful examination of the rich materials here accessible, and by a comparison of the petrifactions with those of the same period found in more southerly localities, Heer has shown that already in the Miocene era considerable variety of climate existed on the face of the earth, though even the pole at that time enjoyed a climate fully comparable with that of Central Europe now. The then flora of Europe had almost entirely an American character, and there are many reasons for supposing that the continents of Europe and America were at that time united, and

[1] We may also mention the evidence of an arctic Miocene flora obtained by Sir John Richardson from fine indurated clay-beds, associated with coal-seams, on the Mackenzie River, near Great Bear Lake, from which seventeen species of fossil plants have been identified by Heer. — EDIT. GEOL. MAG.

bounded on the south by an ocean extending from the Atlantic over the present deserts of Sahara and Central Asia to the Pacific.

Between the Miocene and the present era are two important periods, the Pliocene and the Glacial, which to us are particularly deserving of attention, inasmuch as that during them man, the lord of creation, seems first to have made his appearance. That during the latter of these periods vast masses of ice covered at least all the northern part of Europe is a well-known fact; but concerning the nature of the transition from the glorious climate of the Miocene age to the Glacial period we possess no knowledge whatever founded on actual observation. Probably at some future time contributions towards the solution of this important question may be found amongst the mountain masses that occupy the peninsula between Ice-fjord and Bell Sound in Spitzbergen, or in some parts of the basalt region of Northwestern Greenland. In the interior of Ice-fjord and at several other places on the coast of Spitzbergen, one meets with indications either that the polar tracts were less completely covered with ice during the Glacial era than is usually supposed, or that, in conformity with what has been observed in Switzerland, inter-glacial periods have also occurred in the polar regions. In some sand-beds not very much raised above the level of the sea, one may in fact find the large shells of a mussel (*Mytilus edulis*) still living in the waters encircling the Scandinavian coast. It is now no longer found in the sea around Spitzbergen, having been probably rooted out by the ice-masses constantly driven by the ocean currents along the coasts.

From what has been already stated, it appears that the animal and vegetable relics found in the polar regions imbedded in strata deposited in widely separated geological eras uniformly testify that a warm climate has in former times prevailed over the whole globe. *From palæontological science no support can be obtained for the assumption of a periodical alternation of warm and cold climates on the surface of the earth.*

A careful investigation of the structure of the different sedimentary strata leads to the same result. We are now very well acquainted with the origin and nature of the various strata, the substance of which has been supplied by the destructive operation of glaciers on the surrounding and subjacent mountain masses, and we can point out certain marks by which these strata may be distinguished from other non-glacial deposits. In

these last, one very rarely meets with any large stone bowlders, which have fallen from some neighboring cliff and been imbedded in sand or clay, either directly, and, if so, close to the place where originally found, or else after having in the spring been moved a greater or less distance by river ice. In glacial formations, on the contrary, as one may gather from the study of the strata in Scandinavia that belong to the glacial period, erratic blocks transported on icebergs to far-distant regions play an important part. If a climate similar to that which now prevails in the arctic regions has several times during various geological eras existed in the neighborhood of the pole, one has reason to expect that sandstones inclosing large bowlders should often be met with in these tracts.

But this is by no means the case, though such formations, if they exist on a large scale, could hardly escape observation.

The character of the coasts in the arctic regions is especially favorable to geological investigations. While the valleys are for the most part filled with ice, the sides of the mountains in summer, even in the eightieth degree of latitude, and to a height of one thousand or fifteen hundred feet above the level of the sea, are almost wholly free from snow. Nor are the rocks covered with any amount of vegetation worth mentioning, and, moreover, the sides of the mountains on the shore itself frequently present perpendicular sections, which everywhere expose their bare surfaces to the investigator. The knowledge of a mountain's geognostic character, at which one in more southerly countries can only arrive after long and laborious researches, removal of soil, and the like, is here gained almost at the first glance; and as we have never seen in Spitzbergen nor in Greenland, in these sections, often many miles in length, and including, one may say, all formations from the Silurian to the Tertiary, any bowlders even as large as a child's head, there is not the smallest probability that strata of any considerable extent, containing boulders, are to be found in the polar tracts previously to the middle of the Tertiary period.

Since, then, both an examination of the geognostic condition and an investigation of the fossil flora and fauna of the polar lands show no signs of a Glacial era having existed in those parts before the termination of the Miocene period, we are fully justified in rejecting, on the evidence of actual observation, the hypotheses founded on purely theoretical speculations, which assume the many times repeated alternation of warm and glacial climates between the present time and the earliest geological ages.

RECENT LITERATURE.

ANDERSON'S MANDALAY TO MOMIEN.[1] — Mandalay is the capital of Burma, and Momien an important town in the province of Yunnan, Western China. The two British expeditions of which Dr. Anderson gives a narrative was for the purpose of establishing commercial relations between the British in Burma and the rich provinces of Western China. Both missions were repulsed and entirely unsuccessful, but much information concerning these remote regions was collected by Dr. Anderson, and has been given to the public in this handsome volume. The population is a motley one, the Burmese intermingling with the Chinese, though both live in different quarters of the same towns, and both are confined closely to their walls and fortifications by the fierce hill tribes on the border.

Few notes on the natural history of the country have been recorded, though "a full and illustrated report is in active preparation." The famous tame fish of "the little rocky island of Theehadaw, which boasts the only stone pagoda in Burma, and is resorted to by numbers of pilgrims at the great Buddhist festival in March," are briefly mentioned in the following words: "Having supplied ourselves with rice and plantains, the boatmen called 'Tit-tit-tit.' Soon the fish appeared, about fifty yards off, and after repeated cries they were alongside, greedily devouring the offering of food. In their eagerness they showed their uncouth heads and great part of their backs, to which patches of gold leaf, laid on by recent devotees, still adhered. So tame were they that they suffered themselves to be stroked, and seemed to relish having their long feelers pulled. One fellow, to whom a plantain skin was thrown, indignantly rejected it, and dived in disgust."

While Burma is rich in ruined temples and towns, the prehistoric remains are also abundant. Stone celts are often turned up by the plow in Yunnan as with us. "A large number of those purchased are small, beautifully cut forms, with few or no signs of use, and made of some variety of jade; but there is no reason to doubt the authenticity of the larger forms which were brought to us. Bronze celts are also found, but are valued at their weight in gold; we managed, however, to purchase one at Manwyne on the return journey. It belongs to the socketed type of celts without wings. The composition of the bronze is the same as that of the celts found in northern Europe: tin, 10; copper, 90."

The narrative has been prepared with evident care, and will be useful for comparison with the relations of the recent French expedition to

[1] *Mandalay to Momien.* A Narrative of the Two Expeditions to Western China of 1868 and 1875, under Col. E. B. Sladen and Col. Horace Browne. By JOHN ANDERSON, M. D., etc. With Maps and Illustrations. London. 1876. 8vo, pp. 479. Macmillan & Co. $7.50.

Cochin China, of which finely illustrated accounts are appearing in *Globus*, the early numbers of which for the present year also contain some fine views of Yunnan.

THE GEOLOGICAL RECORD FOR 1874.[1] — This useful work is apparently a complete bibliography of all works, papers, and notes, on geology, mineralogy, and palæontology, published during the year 1874. It will be of course indispensable to American laborers in these fields, especially to those who do not have access to large libraries. The work seems to have been prepared with thoroughness, as there are twenty-seven contributors besides the editor, and it is accompanied by an index. The Record is divided into eight sections, namely, Stratigraphical and Descriptive Geology, Physical Geology, Applied and Economic Geology, Petrology, Mineralogy, Palæontology, Maps and Sections, Miscellaneous and General. Brief summaries of the most important works and essays give it a great value to the working geologist. There are more than two thousand entries.

JOHNSON'S CYCLOPÆDIA.[2] — With Professors F. A. P. Barnard and A. Guyot as editors-in-chief of this compact and useful cyclopædia, the reader may be assured that the articles upon scientific topics are reliable, accurate, and fresh. The associate editors are twenty-seven in number, embracing several of our leading scientists, and there are five assistant editors, whose names are well known in scientific and literary circles. The editors claim that of the articles "not fewer than two or three hundred, at the smallest estimate, are articles upon topics of interest in science, letters, and constructive art, of which the titles do not appear in any contemporary work of the kind; many of them having been, in fact, suggested by the recent progress of scientific discovery or literary research." We notice, in looking hastily through the second volume, articles by the following scientists: Barnard, Chandler, Cooke, Dawson, De Gubernatis, Gill, Goodale, Gray, Guyot, Hitchcock, Hunt, Packard, Riley, Verrill, Willey, Woodward, and Yule.

RECENT CONTRIBUTIONS TO NORTH AMERICAN MAMMALOGY. — During the last few months several important papers have appeared relating to the mammals of North America, chiefly by Dr. Elliott Coues and Dr. Theodore Gill. It is now several years since Dr. Coues began to divide his labors between the North American mammals and birds, his attention having formerly been given almost exclusively to the latter. The first general results of his work upon the mammals appeared in the form of a Synopsis of the Muridæ of North America.[3] This brochure of

[1] *The Geological Record for* 1874. An Account of Works on Geology, Mineralogy, and Palæontology, published during the Year. Edited by WILLIAM WHITTAKER. London: Taylor and Francis. 1875. 8vo, pp. 397.

[2] *Johnson's New Universal Cyclopædia.* A Scientific and Popular Treasury of Useful Knowledge. Illustrated with Maps, Plans, and Engravings. In 4 vols. Vol. ii. 1876. L—Lichens. Royal 8vo, pp. 1767. New York: A. J. Johnson and Son.

[3] Proceedings of the Academy of Natural Sciences, Philadelphia, 1874.

twenty-four pages is based on the material ("several thousand specimens") in the Museum of the Smithsonian Institution, and is stated to be an abstract of a memoir[1] in which the characters of the varieties, species, and higher groups are to be given, with synonymy, bibliography, etc. In this paper the family *Muridæ* is taken in its usual acceptation, with the exclusion of the genus *Jaculus* (= *Zapus*), formerly included among the *Muridæ*. The four introduced species, namely, the common house rats and mice, are mentioned merely by name, but the principal synonomy in the cases of the indigenous species, generic and subgeneric diagnosis, and the geographical distribution of the species and varieties are also added. Of the genus *Neotoma* four species are given, including one (*N. magister*) fossil from the caves of Pennsylvania. The others are *N. Floridana*, under which are placed *N. Mexicana* and *N. micropus* of Baird's General Report on the Mammals of North America; *N. fuscipes*, and *N. cinerea*, the latter embracing also *N. occidentalis* of Baird's General Report. The species of *Sigmodon* are reduced to one, *S. Berlandieri* Baird and *Hesperomys Tolticus* De Saussure being referred to *S. hispidus*. The species of *Hesperomys* are also greatly reduced in number, and are placed in three subgenera: *Vesperimus*, here first characterized, and *Onychomys* and *Oryzomys* of Baird. Of the subgenus *Vesperimus* six species are recognized, including two from Mexico, one of which is described as new. The other four are *H. leucopus*, with four varieties (*leucopus*, *gossypinus*, *Sonoriensis*, *eremicus*, and *aureolus*), *Michiganensis*, and *Californicus*. Under variety *leucopus* are included no less than fourteen nominal species of previous authors, while two others appear under variety *aureolus*. The subgenus *Onychomys* includes two species, one of which (*torridus*) is described as new from Arizona; the other (*leucogaster*) includes also the *Mus Missouriensis* of Audubon and Bachman. The subgenus *Oryzomys* embraces the single species *palustris;* making altogether nine North American species of *Hesperomys*. *Ochetodon* is described as a new genus, with three species given as well-established and two that are doubtful. In a foot-note, under *Ochetodon*, the genus *Ruthrodon* is characterized, and diagnosis given of its two subgenera, one of which (*Euneomys*) is new.

In the arvicoline group (subfamily *Arvicolinæ*) *Evotomys* is diagnosed as a new genus, with one species, the *netelies* of Pallas, which is regarded as circumpolar in its distribution, and as shading southward in North America into variety *Gappari* (= *Arvicola Gappari* auct.). The old genus *Arvicola* is divided into four subgenera, namely, *Myonomes* Raf., *Chilotus* and *Pedomys* Baird, and *Pitymys* McMurtrie, and embraces six species. To the old *A. riparius* Ord, or the common meadow

[1] This memoir forms the first of the Monographs of the North American Rodentia by Coues and Allen, now publishing in Dr. Hayden's quarto series of Reports of the United States Geological and Geographical Survey of the Territories. The monograph of the Muridæ, we are informed, is already in type and will shortly be issued.

mouse of North America, are referred no less than eighteen specific names of former authors, while two other species (*Townsendii* and *xanthognathus*) are only provisionally regarded as distinct from this. The other three species of the old genus *Arvicola* have each also several synonyms, the *A. curlatus* of Cope (from California) being regarded as a variety of *austerus*, and a new variety of *pinetorum* is added, from Southeastern Mexico, a region where the genus was long supposed to be unrepresented. The subgenus *Synaptomys* Baird is raised to generic rank, and embraces the single species *Cooperi*, formerly referred to *Myodes*.

The lemmings of America are reduced to two species, which are referred to two genera — *Myodes* as restricted and *Coniculus* Wagler. The one (*M. obensis*) is confined to the western portions of arctic America, while the other (*C. huelsonius*) is found throughout the Arctic regions generally, and includes several nominal species. The muskrat (*Fiber zibthicus*) closes the list of the North American *Muridæ*.

In no group of North American mammals have such extensive changes been as yet made as Dr. Coues has here found it necessary to adopt; few groups, too, have so much needed careful revision, or present a more difficult field of inquiry. The vast amount of material Dr. Coues has had as a basis for his work, and the evident care he has exercised in its elaboration, lead us to look forward with great interest to the appearance of the promised fuller exposition of the group.

Almost simultaneously with the appearance of this synopsis in its original place of publication, it was also reissued, with additions, as one of the publications of the Northern Boundary Commission, as the "first of a series of preliminary zoölogical reports which may appear from time to time, during the elaboration of the material secured by the Boundary Commission."[1] The additions appear to consist mainly of a list of ten species collected during the survey, with notes on their distribution.

As previously noticed, Dr. Coues, in his definition of the family *Muridæ*, excluded from it the genus *Jaculus*. This genus he has since raised to the rank of a distinct family,[2] to which he has given the name *Zapodidæ*. The results of his investigation of this species he summarizes as follows: (1.) That there is at present only one known

[1] *On the Muridæ of the Northern Boundary Survey, with a Critical Revision of the North American Genera and Species.* United States Northern Boundary Commission. Archibald Campbell, Esq., Commissioner. Major W. J. Twining, United States Engineers, Chief Astronomer. Natural History. No. 1. On the Muridæ. By Elliott Coues, United States Army, Surgeon and Naturalist of the Commission. Reissued, with additions, from the Proceedings of the Academy of Natural Sciences of Philadelphia, 1874. Philadelphia. Collins, printer. 1874. 8vo, pp. 28.

[2] *Some Account, Critical, Descriptive, and Historical, of Zapus Hudsonius.* By Dr. Elliott Coues, United States Army. Bulletin of the United States Geological and Geographical Survey of the Territories. Second Series, No. 5, pp. 253–262, January 8, 1875. It was also reissued separately by the author, the separate copies bearing date 1875.

species of *Zapus*. (2.) That this species, usually referred to the *Muridæ*, differs from the *Muridæ* to a degree warranting its recognition as a distinct family, as was done by Dr. Gill in 1872. Its principal characters are the presence of an upper premolar not found in *Muridæ* proper, the different and peculiar construction of the ante-orbital foramen, and the saltatorial development of the hind limbs. (3.) That none of the various generic names that had been applied to this species were tenable, according to recognized rules of nomenclature. He then proceeds to show why the former generic appellations of *Meriones*, *Jaculus*, *Dipus*, and *Gerbillus* are inapplicable, and proposes the new one of *Zapus*, in allusion to its large hind feet. The adoption of this name for the genus he considers as necessitating the changing of the family name from *Jaculidæ* to *Zapodidæ*. Then follows the generic and specific synonomy, amounting to one and a half pages, the latter embracing more than a dozen specific names, four of which have had, at different times, considerable prominence. Detailed descriptions are also given of the cranial, dental, and external characters of the genus, with a notice of its geographical distribution, and remarks on its synonymy.

Brinton's Myths of the New World.[1] — "Picking painfully amid the ruins of a race gone to wreck centuries ago, rejecting much foreign rubbish and scrutinizing each stone that lies around, if we still are unable to rebuild the edifice in its pristine symmetry, yet we can at least discern and trace the ground plan and outlines of the fane." This is what the author has most successfully done, and the results of his studies are attractively embodied in the handsome volume before us. Freed from the false interpretations so frequently placed upon them, we have here given us what certainly can be accepted as a very correct idea of the mental condition and peculiarity of those strange tribes of men, the so-called Indians of North and South America. Chapters II. to X. inclusive cover the fascinating field of study suggested by the ideas of God among the Red race; Sacred Numbers, The Symbol of the Bird and Serpent, Myths of Water, Fire, Thunder, and the Religion of Sex; also the subject of their Supreme Gods, The Myths of Creation, the Deluge, Nature's Epochs and the Last Day. Chapters VIII. and IX. are devoted to the subject of the origin of man and the soul and its destiny, as these vexed questions of our day were looked upon by the Red men, and to us are the most entertaining chapters of the work. The author traces back the myths of the Red men generally back to the one solar myth, and disposes of the personality of their god-like heroes, as Quetzalcoatl, Viracocha, and Michabo.

The opening chapter, a general consideration of the Red race, is not, to us, quite so satisfactory as the body of the work. While a most excellent *résumé* of the proofs of the antiquity of American man is given,

[1] *The Myths of the New World.* A Treatise on the Symbolism and Mythology of the Red Race of America. By D. G. Brinton, A. M., M. D. Second Edition, revised. New York: Henry Holt & Co. 1876. $2.50.

such as his *isolation*, being "cut off time out of mind from the rest of the world," and the fact that "the remains of primeval art and the impress he made upon nature bespeak for man a residence in the New World coeval with the most distant events of history," the author, if we understand him aright, adopts the theory of the unity of the human race. If by unity is meant a common origin from one creative centre, and that a creation *de novo*, rather than derivative, then we dissent. Indeed, reasons are given in every chapter of the work, for believing that the Red race of America never had any intercourse, or bore any relationship to other peoples of any portion of the globe, unless we trace man back so far into time past that we see him the occupant of continents not now existing as such. A word, and we have done. On page 35, Dr. Brinton states that "not a tittle of evidence is on record to carry the age of man in America beyond the present geological epoch." In this connection we would call attention to the remark of the late Professor Wyman, on page 45 of Fresh-Water Shell-Mounds of Florida, as follows: "The ancient remains found in California . . . by Professor J. D. Whitney, and referred by him to the tertiary period," etc., etc. To this is added an important foot-note, that "the ample evidence collected by Professor Whitney, but not yet published, substantiates the opinion given above with regard to age." We have, therefore, something more than a tittle of such evidence, and we are carried back to a time when man in America was even too primitive to originate those curious myths which afterwards became so marked a feature of their lives, and which Dr. Brinton has most successfully interpreted.

Recent Books and Pamphlets. — Prehistoric Man. Researches into the Origin of Civilization in the Old and New Worlds. By Daniel Wilson. Third edition, revised and enlarged, with illustrations. 2 vols. London: Macmillan & Co. 1876. 8vo, pp. 399, 401.

List of Skeletons and Crania in the Section of Comparative Anatomy of the United States Army Medical Museum, for Use during the International Exhibition of 1876, in Connection with the Representatives of the Medical Department, United States Army. Washington, D. C. 1876. 8vo, pp. 52.

An Account of the Worcester Lyceum and Natural History Association. By Nathaniel Paine. Prepared for the International Exhibition, 1876. Worcester. 1876. 8vo, pp. 13.

On some Characters of the Genus *Coryphodon* Owen. By Professor O. C. Marsh. 8vo, pp. 4. (From the American Journal of Science and Arts, vol. xi., May, 1876.)

GENERAL NOTES.

BOTANY.[1]

Arrested Growth and Persistence of Barbula ruralis. — During a visit made to Ile Royale, Michigan (Lake Superior), in the summer of 1874, my attention was called to a curious example of the

[1] Conducted by Prof. G. L. Goodale.

preservation of such a fragile organism as a moss, while what we regard as more enduring objects perish and disappear. At Scovill's Point, a sharp, high tongue of rock, of trap formation, running out into the lake for several hundred feet, the almost level summit presents a large space thickly carpeted with the moss *Barbula ruralis* Hedw. In this were inscribed a number of names and dates, made by simply cutting away the moss and letting the underlying rock appear. The inscriptions, mostly in bold characters of several inches in length, were in general distinctly legible, the dark green (almost black) moss preserving the outlines, and appearing, with few exceptions, to have remained at a stand-still — neither decaying nor growing — since the writings were made.

One of the most prominent names was that of the gentleman after whom the point is called. This has the date '46 attached to it; and a friend, a mutual acquaintance, who accompanied me and pointed out the place, informed me that in the year denoted (twenty-eight years before), the gentleman, visiting Ile Royale, to his surprise, found inscriptions in the moss here, and added his name with the date. His son was with him at the time, and, revisiting the island in 1872, climbed up here to see whether any trace of his father's writing remained, and to his astonishment finding it as well as the other inscriptions undisturbed, cut his own name with the date — all in the Barbula. The isolated locality, and the steep (mostly perpendicular or overhanging) sides of the cliff, render it probable that few persons would find their way to the spot without some such object in view. The inscriptions, as seen by me in 1874, were as follows: "June — 1825." "— 43." "P. A. Scovill, '46." "— 1847. — " O. C. Scovill — 1872."

The first of these inscriptions I have thought may have been made by the party of Captain Bayfield, R. N., who about the date given made his survey of Lake Superior, undoubtedly visiting this island. That it and the other older ones should be preserved for such a length of time in so fragile a substance, is surely remarkable. From the time at which I saw them to the earliest date would cover a period of forty-nine years. And most interesting is the evidence here conveyed of the persistence of the moss, coupled with its arrested growth. The plants were so dry and brittle as to be easily rubbed to powder between the hands, and could with difficulty be removed without breaking them. Yet on placing some in water they revived so as to apparently present full vitality.

This is not the first time I have had my attention called to this plant and its semi-torpid habit. It must be of exceedingly slow growth; and I believe it is but rarely found in fruit. Though it is abundant on Lake Superior, I have never met a fertile specimen. — HENRY GILLMAN, Detroit, Michigan.

ON THE HYGROSCOPIC MECHANISM BY WHICH CERTAIN SEEDS ARE ENABLED TO BURY THEMSELVES IN THE GROUND. — Mr. Francis Darwin read an interesting paper on this subject at a recent meeting of

the Linnean Society of London. The plant on which his observations were made was chiefly the feather-grass, *Stipa pennata*, but the same phenomena exist in many grasses, in *Anemone montana*, and in some of the Geraniaceæ. The essential points of structure common to all these self-burying seeds are: (1) a sharp point more or less covered with reflexed hairs; (2) a strong woody awn sharply bent at one point so as to be divided into a lower vertical and an upper more or less horizontal part, the vertical part being strongly twisted on its own axis (or forming a helix as in the Geraniaceæ). The hygroscopic phenomena exhibited by all the seeds are, (1.) On being wetted the vertical part of the awn untwists, and causes the straight horizontal part to revolve and describe a circle in a horizontal plane; the angle between the vertical and horizontal parts also gradually disappears, and the awn becomes straight. (2.) As the awn becomes dry again, the movements just described are reversed, the angular bend and the torsion of the lower part of the awn appearing. The process by which the seed of *Stipa* buries itself is as follows: the long feathery horizontal part of the awn is easily entangled in low vegetation, and the seed is thus held in a more or less vertical position, its point resting on the ground. When the awn becomes wet it tends to untwist, but the horizontal part being unable to revolve, the rotation is transferred to the seed; the tendency of the seed to straighten itself is also converted into pressure of the point of the seed against the soil. As the awn dries again, the seed is not pulled out of the ground, as would be the natural result of the reversal of the movements by which it was buried. On the contrary, it is actually thrust deeper into the soil during the process of drying. By the combination of these two alternate actions the seed is completely buried. What special advantage it may be to a plant that its seeds should be buried is uncertain; in the case of *Stipa*, at least, it seems to have no connection with germination; it is conjectured that it may serve as a protection against graminivorous birds, etc. The explanations given by Hildebrand of the twist in the awn of the wild oat, and by Hanstein of the torsion of the awn of *Erodium*, appear to be inadequate to explain the phenomena. The hygroscopic torsion of the awn appears really to depend on the power of torsion residing in the individual cells of which the awn is composed. Thus when an isolated cell is dried it twists on its own axis in precisely the same manner and direction as the awn itself; and just as the latter untwists in moisture, so do the individual cells in like condition. It is demonstrable that the torsion of the separate cells must cause the awn to twist as a whole. This remarkable power appears to depend on the molecular structure (stratification and striation) of the walls of the twisting cells. Although it was previously known from the researches of Nägeli and others, that certain cells become twisted in drying, yet their combination so as to produce torsion in a considerable mass of tissue has not before been observed. Neither

has the power of torsion in drying, possessed by the cells, been hitherto shown to be of use in the economy of any plant. — A. W. Bennett.

The Potato Disease. — The supposed discovery of the sexual reproductive organs of *Peronospora infestans*, the fungus which causes the potato-blight, by Mr. W. G. Smith, continues to attract much attention in England and on the Continent of Europe. The eminent mycologist, Professor De Bary, of Strasburg, does not altogether accept Mr. Smith's conclusions, believing that what he considers the resting-spores of *Peronospora* must belong to some other fungus accidentally present in the decaying tissue; and his views were recently explained at the Linnean Society of London by Mr. Carruthers, F. R. S. Professor De Bary proposes to divide the group Peronosporeæ into three genera. In *Cystopus* the conidiophores grow in large bunches, the conidia being developed in single rows in basipetal order. In *Peronospora*, from a tree-like mycelium, conidiophores arise singly or in small bunches at the ends of the branches, and have no successors in the direct line. The new genus, *Phytophthora*, to which the old *Peronospora infestans* belongs, differs in its multiple and successive conidia, which, when shed, leave swellings on the branches. In all three genera the ripe conidia, when placed in water, produce ciliated zoöspores, which penetrate the tissue of the host and develop threads or mycelium. By another and sexual mode of propagation the oögonia, bladder-shaped female cells, after being fertilized by the small male cells or antheridia, produce from their protoplasm a thick-walled oöspore, from which mycelial threads sprout, and the process is then repeated. A considerable period of inactivity may, however, precede the germination of the oöspore, which in this case hibernates during the winter, while its host decays. The conidia propagate and spread the fungus during the summer season only, and do not live through the winter. Professor De Bary has found in decaying potato-tubers bodies exactly corresponding to oögonia. On experimenting with the oöspores of these and planting them in potato-plants he obtained minute bodies which conducted themselves precisely like zoöspores, and in most respects resembled those of *Pythium*. Other experiments with them, on the moistened legs of dead flies and bodies of mites, resulted in their complete phases of development which were watched step by step, the zoöspores producing a plentiful crop of mycelium, etc. As this new fungus differs in many ways from *Phytophthora infestans*, De Bary proposes to call it *Pythium vexans*, and he regards it as belonging to the Saprolegnieæ. The fungus named by Montagne *Artotrogus*, and the warty bodies found associated with it he believes to be two forms not connected genetically, and only imperfectly known. He has likewise investigated the question of the perennial mycelium of *Phytophthora* occasionally hibernating where the oöspores are not found in the district, and believes that he has proved that there are two methods by which the conidia may pass from the tuber to the foliage. — A. W. B.

Aplectrum with Coral-like Root. — Early in April, 1876, in transplanting some *Aplectrum hyemale* Nutt., from the woods northwest of Detroit, I found two adjoining plants of this species having branched and toothed coral-like roots, similar to those of *Corallorhiza*, immediately beneath the usual bulb or corm, which was also provided with the ordinary rootlets. Each plant had the green leaf which the species sends up in autumn. A close examination of forty-three additional plants from the same woods failed to discover another instance of this interesting and significant peculiarity. I have transplanted from this place, at various seasons, during eleven years over one hundred specimens of this plant; but never before found a case like the above-described. The coral-like roots seemed parasitic on the partly decayed bark of a tree-root, and the whole was imbedded in ice, the frost still being in the ground. The absence of the coral-like root has been made a generic distinction separating *Aplectrum* from *Corallorhiza*.

I have sent the specimens to Professor Gray, who previously had never seen nor heard of this "unexpected fact." I request of botanists throughout the parts of the country where this plant is found, to search for the peculiarity, that we may learn whether it exists elsewhere, and to what extent; though, from my own experience, I think it likely to prove most exceptional. — Henry Gillman, Detroit, Michigan.

Researches in Regard to Growth. — The method pursued by Reinke appears to be a modification of that employed in the laboratory at Würzburg, and for which he does not give the credit due. The improvement in the apparatus seems to be a real one. A balanced and therefore tight thread goes from the growing plant over a wheel, which by index and multiplier enables the observer to watch and record the growth. A microscope of long focus is used to read the vernier. A notice of the results obtained by the use of this apparatus must be deferred.

Rhynchospora capillacea var. leviseta. — This is named and was discovered by the Rev. E. G. Hill, and is characterized by having the perianth bristles *perfectly smooth*, while in the ordinary form they are downwardly denticulate-roughened. Except in this remarkable particular the plant appears to be undistinguishable from *R. capillacea*. Mr. Hill found the plant in wet pine barrens, around the head of Lake Michigan, at Pine Station, Indiana. There is another variety, hardly needing a name (at least until it is confirmed by finding it constant, and in other stations), discovered in Herkimer County, New York, in 1864, by Professor J. A. Paine, which has twelve bristles (instead of the ordinary six), and the remarkable stipe to the akene is rather shorter than usual. — A. Gray.

An Herbarium for Sale. — An herbarium containing specimens illustrating six thousand species of plants is offered for sale. Full particulars can be obtained from President Chadbourne, of Williams College, Williamstown, Mass.

Botanical Papers in Recent Periodicals. — *Comptes rendus*, No. 9. Boussingault, On the Influence exerted by Vegetable Mold on the Nitrification of Nitrogenized Substances used as Manures. S. Cloëz, On Elæococca Oil, and its Modification by Light. Ed. Heckel, On the Movements of the Hairs and Glands of the Leaves of *Drosera rotundifolia*, and in the Leaves of *Pinguicula vulgaris*. No. 10. A. Barthélemy, On the Absorption by Plants of Bicarbonates in Natural Waters.

Flora, No. 5 and continued in No. 6. Dr. H. Müller, On Heliotropism. (The following conclusions are reached: (1.) In a growing organ of a plant only those zones which have not yet finished growing, exhibit curvatures dependent on light. (2.) The heliotropic curvature is produced by *all* the sensitive zones during extension. (3.) The parts which grow most rapidly are most sensitive to light. (4.) Even negative heliotropism (curvatures away from the light) as in roots is most marked when growth is most vigorous. (5.) Heliotropic curvatures do not cease at once when the light is removed. (6.) The rate of the curving is slow at first, then is accelerated, reaches a maximum, after which it diminishes. (7.) The curvature is not always at the same place; it recedes gradually towards the lower end of the growing stem. (8.) The smaller the angle which the incident rays of light make with the axis of the stem, the slighter will be the effect produced. (9.) Heliotropism continues until growth ceases or until light has been brought to act upon two sides of the plant, or until the curvature from light is overpowered by curvature from gravitation (geotropism). (10.) Heliotropic curvature, under similar circumstances, increased with intensity of light. (11.) Stems which have been previously kept in the dark are more sensitive to light coming from one side, than are those which have been previously illuminated on all sides. (12.) The concave side, which is the one most highly illuminated, grows less rapidly than the other. (13.) Negative curvatures are not accompanied by uniform growth throughout all zones but are characterized by growth only in the lower zone. (14.) Heliotropic curvatures are more rapid when geotropism is excluded. (15.) Geotropism counteracts heliotropism, to differing degrees in different plants. (16.) Certain parts or stems are sensitive to light, and others are highly geotropic. (17.) Some negatively heliotropic roots are hindered in growth when they are illuminated on all sides.) X. Landerer, of Athens, Botanical Notes from Greece. No. 7 and 8. Hugo de Vries, On Wood Repairing Wounds (continued). J. Sachs, On Reinke's Investigations respecting Growth. (Alleging that what Reinke has lately published in regard to a new instrument for measuring rate of growth suppresses the fact that the method used is substantially that employed by Sachs.) A. Geheeb (noticing mosses from near the Rhone).

Botanische Zeitung, No. 11. Ph. Van Tieghem, New Observations respecting the Development of the Fruit and the supposed Sexuality

of *Basidiomycetes* and *Ascomycetes.* (Noticing Brefeld's paper, and claiming that Brefeld has substantially *confirmed* the results of Van Tieghem's early researches.) Max Reess, A Correction (of an alleged error in Brefeld's memoir). Reinke, Investigations Respecting Growth. No. 12. Dodel-Port, Concerning the Swarm-spores of *Ulothrix zonata.* Reports of Societies: Amsterdam, Jonkman, On the Prothallium of *Marattiaceæ.* No. 13. Th. Irmisch, A Contribution to the Natural History of *Cactaceæ.* (Considering the seedlings of *Rhipsalis.*) No. 14. In Reports of Societies: Gottingen. Holle, On the Organs of Vegetation in *Marattiaceæ.* Holle, On a New Camera (using a double mirror).

ZOÖLOGY.

The European Woodcock shot in Virginia. — A few days ago I received from Dr. M. G. Ellzey, of Blacksburg, Va., the information that "a European woodcock was shot in Loudon County, in November, 1873," by his brother, with a number of the common species these gentlemen secured together. The alleged occurrence being one of much interest, I wrote, asking for further particulars, in order to secure the "internal" evidence necessary to place the matter beyond question. Dr. Ellzey appears to be perfectly competent in the case, from the particularity of the reply with which he has favored me. "The flight of the bird was slower, heavier, and nearer the ground than that of the familiar bird. When compared with twelve or fifteen of the latter, it appeared at least twice as large as the largest of them; the wing was longer, more pointed, and possessed but one falcate primary. The bird was found to weigh fourteen and one half ounces; it seems to me that this weight alone is sufficient to determine the species, the heaviest American woodcock ever weighed by me being only seven and one half ounces, while the average is about five and one half. Moreover, the character of the wing settles the matter beyond dispute. I was at the time aware of the peculiarities of the European bird as compared with ours in this respect, and made the comparison with such care as to preclude possibility of mistake. I had not at the time, nor have I since had, the smallest doubt of the correctness of my diagnosis. The bird was not preserved, as I wished, to be sent to a taxidermist for mounting, but was cooked and eaten with the rest."

We have several authentic records of the casual presence of *Scolopax rusticola* in America, besides some less explicit references to the same fact in the works of leading sporting writers; but so far as I now remember, there has hitherto been no recorded instance of the occurrence of the species south of New Jersey. — Elliott Coues.

Notable Change of Habit of the Bank Swallow. — In treating of this bird (*Cotyle riparia*, Birds of the Northwest, p. 87), I state, "It becomes an interesting question whether the bank swallow will ever abandon its burrows, and so far modify its fossorial nature as to

build in chinks and crannies, or affix a nest anywhere about a building." The matter is already decided, and the surmise verified, as I learn from a correspondent, Dr. Rufus Haymond, well known by his contributions to the ornithology of Indiana. He writes as follows: "The depot of the White Water Valley Railway, in Brookville, Indiana, is built upon stone piers, and spans the hydraulic canal, some five or six feet above the water. While at the depot during the past summer I saw a bank swallow fly under the building with several blades of grass in her bill; and being curious to see what she would do with them, I watched her, and saw her carry them through a two-inch auger hole which had been bored through a pine board. The spot was inaccessible, owing to the water; but I know from the droppings about the hole that this was her nest." I have never seen or heard of any previous record of such habit, and consider Dr. Haymond's statements very interesting. — ELLIOTT COUES.

THE CHAPPARAL COCK. — Can any of your ornithological readers give us any information as to the food of the chapparal cock, or road runner, as it is usually called in this region (*Geococcyx Californianus*). It is found, though it is not abundant, along the foot-hills in this vicinity. A friend gave me a specimen killed here a few days ago, but I believe it is not found north of the "Divide." On mounting the bird I found in its gizzard no recognizable matter except *débris* of grasshoppers, and as no one has seen a grasshopper alive here for two months, the question is, Where did the bird get them? Does it provide its food in the season, laying it up for winter? One of the grasshoppers was in perfect condition, except that it had lost some of its legs. Under a lens the mass of the comminuted material was seen to consist of minute pieces of legs and integument of grasshoppers. — V. T. CHAMBERS, Colorado Springs, Cal.

THE "SISCO OF LAKE TIPPECANOE." — I am informed by Mr. J. A. Henshall of Oconomowoc, Wis., that the fish described by me under the above name (*Argyrosomus sisco*, AMERICAN NATURALIST, March, 1875, p. 135) occurs in abundance in Nemahbin Lake, Waukesha County, Wis., which empties into Rock River, through Bark River, and in Okauchee, Oconomowoc, and La Belle lakes, in the same county, which send their waters also to Rock River by way of the Oconomowoc.

A notice of this species occurs in Rafinesque's Ichthyologia Ohiensis, p. 44, as follows: —

"The white fish of Lake Erie, *Coregonus albus* of Le Sueur (or *Salmo clupeiformis* of Dr. Mitchell), a fish which differs from the trouts by being toothless, is said to be found in some streams of Indiana at the head of the Wabash and Miami; but I have no certain proof of this." — D. S. JORDAN.

CORALS AND CORAL ISLANDS; BY JAMES D. DANA. — We are not going to review the book, as it is one which we suppose a large part of our readers are familiar with already. We only propose that they shall

share with us the amusement we had in reading a review of it in the *British Quarterly* for October last. Here is a sentence: "Professor Dana, who is another Hugh Miller, made his mark as a writer many years ago by his Two Years before the Mast. The man who could write that was clearly marked out for something better than the life of an able-bodied seaman; but few who have risen in life as he has have been able to turn to such use the lessons of sea-faring life learned in earlier years."

"The man who could write that" precious sentence in a quarterly review, confuse two men of such mark, and educe either of them from an illiterate sailor, has earned thereby a word of notice.

Note on the Blue Goose. — A few years ago I came upon a flock of four *Anser cærulescens*, about two miles west of this place, in April. They were feeding upon a grass-plot upon the bank of the west fork of White Water River. As I approached them, and before I discovered them, they rose up from the ground very much in the manner of the mallard. I shot one some days later, breaking its wing, and brought it home with the hope of saving it, but it died in a few hours. One of the three left was afterwards shot by one of my neighbors, Mr. Halstead, with a rifle. The wing was shot off at the wrist joint. He secured the goose, took it home, fed it, and it became as tame as a domestic goose. He lived near the bank of the river, but, notwithstanding he had tame geese with which it associated, it would never approach the water, but would stand upon an elevation and watch those in the river. He kept it a year, from April to April, but a hurricane which occurred in the last April blew a fence down upon it and killed it. I saw it in the fall after he caught it. It ate corn very greedily, but, unlike the common goose, did not swallow the corn whole, but picked up every grain, placed it between the outer edges of the bill and bit it in two, the bill snapping like a steel-trap. This, to me, was a curious fact, but the fact that for a whole year it never entered the water was still more astonishing. — Rufus Haymond, Brookeville, Indiana.

Occurrence of Maggots in a Boy. — Dr. G. W. Martin, a homœopathic physician, and a very intelligent, well-informed gentleman, was recently (June 5th) called to see a patient, a lad of about fourteen years, who had been seized with violent spasms. The doctor gave as an assistant remedy a purgative, whereupon the lad passed at one stool about fifty little insects or bugs, as he called them. The doctor brought them to me and I told him that they were dipterous larvæ. I requested him to put some in a box of moist earth covered with glass, and the flies appeared on the 17th of June. Now can you tell what the fly is? — Gilbert S. Judd, Maysville, Ky., June 22, 1875.

[On submitting the flies to Baron Osten Sacken, he wrote us as follows: "The fly you gave me is *Anthomyia* (Homalomyia) *scalaris*, one of those mentioned in the *American Entomologist*, ii. 139, and of

which similar experience is recorded in Europe." The article referred to is entitled Larvæ in the Human Bowels. It is by the late Mr. Walsh, and gives a good summary of what is known of the subject in this country. See also Guide to the Study of Insects, pp. 366, 367. — Ed. Naturalist.]

Swedish Podurans. — The *Poduridæ*, or "spring-tails" of Sweden, have been monographed in an elaborate way by T. Tullberg. The memoir is accompanied by twelve plates, and enters quite fully into the anatomy of these little creatures of so much interest to microscopists. The work appears in the Transactions of the Royal Swedish Academy for 1871, and has just reached this country.

ANTHROPOLOGY.

An Interesting "Find" of Indian Relics. — A very interesting "find" of Indian relics has been obtained by the writer, from a locality not previously examined, although within a short distance of the site of his collecting labors of the past three years. By the uprooting of a large tree during the tornado of Tuesday night, February 1st, and a consequent landslide on the south bank of Crosswick's Creek, near Yardville, Mercer County, New Jersey, the traces of the site of a former "homestead" were brought to light, consisting of corn-mills, pestles, axes, hammers, spears, and arrow-points, associated with innumerable fragments of bones, mussel-shells, and charcoal. No fragments of the bones were sufficiently large to determine the animals to which they belonged, beyond the fact that while some undoubtedly were fragments of mammal bones, the vast majority were those of birds and large fishes. The main feature of interest connected with the stone implements is the uniform character of the workmanship displayed in their manufacture. There was not found one polished celt, or a single specimen of jasper arrowhead. The find consists of the following specimens: Sixteen arrow-points varying from four inches to one and one half in length; they are all of the same mineral, a slaty rock, and now very much weather-worn, soft, and pliable. One spear-head, six inches in length, made of the same mineral and equally weather-worn. Five specimens varying between the spear and knife forms, one of white quartz, and all of the same character of workmanship. One specimen of an elongate, lozenge-shaped implement, seven inches in length by two in greatest width, and pointed at each end; the edges have been chipped; very much weather-worn. These twenty-three specimens, found as they were together, bear us out in our remarks in the February number of the Naturalist, that specimens found deep in the soil, as a class, are less elaborately wrought than those found nearer the surface. They were lying, when exposed to view, about two feet below the surface, and the character of the soil is such that its accumulation is wholly due, I believe, to the gradual decomposition of vegetable matter, commingled with fine sand, such as gentle winds will

carry as "dust." If, as was suggested in the February number of this journal, one inch of soil will accumulate in one hundred and twenty-eight years, these specimens are fully thirty centuries old, and certainly their general appearance is suggestive of as considerable an antiquity.

The large specimens that were taken from the mingled dust and ashes of this ancient dwelling-place comprise two corn-mills, as they are usually called. They are both large, quadrangular, sandstone bowlders, one with the depression only on one side, the other with a shallow cup on each side. With them was one globular pebble three and one half inches in diameter, that evidently had been used as the crusher, in reducing the corn or nuts to a powder. The grooved stone axes were thirteen in number, varying somewhat in pattern, but particularly noticeable in that but two were of that form in which the groove does not extend entirely around the head of the ax, but leaves a smooth surface on the upper edge.[1] This pattern may be of later date than those with the groove extending entirely around the specimen. I have found, on comparing many hundreds of these relics, that as a rule those with the groove not encircling the implement are more accurately finished, and with a greater extent of polished surface. Pebbles of a very regular outline were chosen, and the variation among them was in size only. On the other hand, pebbles not at all symmetrical were frequently chosen for axes, grooved and ground to an edge at one end; but such non-symmetrical specimens, I believe, always have the groove extending entirely about them. The thirteen specimens here mentioned vary from eight to four inches in length. The workmanship displayed in their production quite accords with the rude arrow and spear points with which they were associated. Not one can be called a first-class ax, although some certainly are better finished than others. There occurred two specimens of chipped clay-slate implements, that approach the ax in form, and which were evidently designed as cutting implements. One is quadrangular, six inches in length by four in width, and about one inch in thickness. The chipping is easily traced over the entire surface. There is no trace of a polished edge or groove. A slight depression on the upper and lower margins indicate that a handle was once attached to the specimen, as ordinary grooved axes were hafted. The accompanying specimen is still ruder in finish, but has a better-wrought edge. It is obtusely triangular in outline, and a little shorter and narrower than the preceding. The pestles are eight in number and vary from one foot to four inches in length. None are polished and worked into an accurately cylindrical shape, and the larger ones all have the heads so battered as to show that they were used as we use modern pestles in mortars, and not as "rollers," or war-clubs, as some have suggested. The other specimens, eight in number, consist of two net-sinkers, two hammer-stones, a scraper, and three cobble-stones, two of which have been somewhat

[1] The American Naturalist, vi. 145, Figure 10.

chipped, as though intended one for an ax, the other for a chisel or gouge. The other is a curiously shaped stone, that has been utilized as a hammer or nut-cracker. The shape may be designed and not accidental. It is quite certain that the aborigines made use of stones of convenient shapes, for many of the simpler household purposes; but it does not follow because no trace of chipping or polishing is to be detected upon these stones, that the stone has been accidentally so shaped, for the long-continued use of a broken stone would tend to wear it down and so obliterate the trace of the fracture. A survey of the fifty-four specimens constituting this "find," together with the circumstances under which they were discovered, afford, I think, valuable additional evidence of the facts, as I believe them to be, with reference to the stone implements found in North America generally, which are that those found most deeply embedded are the older, and that there is abundant reason for considering that during the occupancy of the Atlantic coast of North America, the Indians advanced from a lower to a higher stage of stone-age culture. — CHARLES C. ABBOTT, M. D.

ANTHROPOLOGICAL NEWS. — Colonel Charles Whittlesey contributes to the *Scientific Monthly* of Toledo, for November, 1875, articles on the Rock Inscriptions in Amherst, Lorain County, Ohio, and on The Comparison of the Indians and Mound Builders.

A story has been going the rounds of the papers to the effect that pygmy graves exist in Tennessee and Kentucky. It is not new, Haywood in his Natural and Aboriginal History of Tennessee having attempted to substantiate the notion. The following evidence that no pygmy race left their remains in this part of our country must be conclusive. Mr. S. E. Haskin, writing from Pine Falls, Tennessee, after having opened twenty small slab-graves in White County, says that the graves vary in length from fifteen inches to two feet, and in width from seven to fourteen inches. He sends with his letter a package of bones and teeth. Some of the latter are milk teeth, and in one fragment of a jaw-bone the second teeth are pushing out behind the milk teeth. Mr. W. M. Clark, employed during the last year by the Smithsonian Institution, to investigate the same subject, and who sent the relics mentioned by Bessels in his paper in the Bulletin of Hayden's Geological Survey, (Vol. II., No. 1), has written for the Smithsonian Report for 1875 a long account of his labors, in which he distinctly proves that the little slab-graves are either those of children or are ossuaries. But the most exhaustive refutation of the whole matter is contained in Chapter II. of a paper, accepted for publication in a forthcoming volume of the Smithsonian Contributions to Knowledge, by Dr. Joseph Jones, of New Orleans. The entire subject is reviewed, from Haywood's work down, and the most convincing proof brought forward from the examination of hundreds of graves, that the small cists are either children's graves or ossuaries. In the former case the fragile jaw exhibits two sets of teeth; in the latter

case parts of more than one skeleton are found. Furthermore, in the same mound with the so-called pygmy graves are found long graves in which the skeletons of unusually tall men and women lie at full length.

The International Congress of Americanists will hold its next session at Luxemburg, from the 10th to the 13th of September, 1877. They have already issued their circular of invitation.

Mr. Charles M. Wallace contributes to the *American Journal of Science* for March an article in which he claims to have found in the beds of brick, clay, and stratified gravels, near Richmond, Va., various hatchet-like, disk-like, and spear-shaped palæolithic implements, from four to eight feet below the surface. "One of them is somewhat like an implement from the Reculver Pits" (Evans, p. 534, N. Y., 1872). The name of Professor Baird is used in the article as *encouraging* the author (he encourages every diligent seeker for truth); but I am sure Mr. Wallace does not mean to say that Professor Baird *endorsed* his conclusions as to the nature of his finds. Two things are necessary to be done in the case. The most scrupulous care is to be exercised in determining exactly all the conditions of the find, and the implements must be compared with similar ones from other localities by skilled archæologists before any safe conclusion can be reached.

The Paris Anthropological Society has issued separately the craniological and craniometrical instructions, prepared by a committee of that body.

Both the January and the February numbers of *Matériaux pour l'Histoire primitive et naturelle de l'Homme* are full of interesting matter. All lovers of archæology should encourage this periodical, whose editors, at great personal sacrifice, conduct it solely in the interest of science.

The Rev. William Houghton read a paper before the Society of Biblical Archæology, March 7th, on the Mammalia of the Assyrian Monuments; Part I., Domestic Mammals. There are three forms of representation: (1) by pictorial or sculptural representations; (2) by description; (3) by picture and description combined. The domestic animals known were the ox, sheep, goat, camel, ass, horse, mule, and dog. The author promised a subsequent paper on the Wild Animals.

George Smith writes to the *Athenæum* of February 12th, "I have discovered a Babylonian text giving a remarkable account of the temple of Belus at Babylon. It is the first time any detailed description of a temple has been found in the cuneiform texts."

Mr. E. B. Tylor read before the London Institution, March 23, 1876, a paper on the Races of Mankind and Their Civilization. The following works on anthropology have appeared: Hellwald, Culturgeschichte; reviewed by Tylor in *Academy*, February 26th. Wilson, Prehistoric Man, 2 vols., Macmillan. Gill, Myths and Songs of the South Pacific, King & Co., London. Koner, Bibliography of Anthropology. Garland, Atlas der Ethnographie, Leipzig, Brockhaus.

GEOLOGY AND PALÆONTOLOGY.

THE TÆNIODONTA, A NEW GROUP OF EOCENE MAMMALS. — At a recent meeting of the Academy of Natural Sciences of Philadelphia, Professor Cope described the character of some mammalia from the Eocene deposits of New Mexico, obtained by him during the Wheeler Expedition of 1874, which he regarded as allied to the *Insectivora*. The feet are armed with compressed claws. The dental characters are seen first in the supposed superior incisors. Unfortunately they have not yet been found in place in the cranium, but their association with a rodent type of inferior incisors, which have been found in place in the mandible, confines us to the alternative choice between superior incisors and canines. From the small size or absence of inferior canines a similar character may be inferred for the superior canines.

The superior incisors present two bands of enamel, an anterior and a posterior. They are compressed in form, the sides presenting a surface of dentine or cementum. Attrition produces a truncate or slightly concave extremity. The inferior incisors are rodent-like.

Two families represented this suborder in the Eocene period in New Mexico. The first, or *Ectoganidæ*, possessed molar teeth with several roots; in the *Calamodontidæ*, each molar has a simple conic fang. But one genus of each family is known. In both the enamel of the molars is principally a band on the outer side of the crown; the deficiency is supplied in *Calamodon* by a deposit of cementum which invests the molar and superior incisor teeth, covering the crowns excepting where the enamel bands are present. The latter investment is so much thinner that the cementum forms a raised border all round at the point of junction of the two substances. The general structure of *Calamodon* affords some points of approximation to the *Edentata*, which indicate that the *Tæniodonta* partially fill the interval between that order and the *Edentata* presented by the existing fauna.

Professor Cope also pointed out the close resemblance between the mandibular dentition of the contemporary Eocene genus *Esthonyx* and the existing *Erinaceus*, and stated that *Anchippodus* and allies chiefly differ from *Esthonyx* in the persistent growth of the incisor teeth.[1]

GEOGRAPHY AND EXPLORATION.

PERUVIAN GEOGRAPHY. — The publication of the preliminary volume of Don Antonio Raimondi's great work, El Peru, will be, says a writer in the *Geographical Magazine*, an epoch in the history of Peruvian geographical research. This accomplished and indefatigable geographer and naturalist had traveled over every part of the republic, on a fixed plan, during a space of nineteen years, diligently collecting materials be-

[1] See On the Supposed Carnivora of the Eocene of the Rocky Mountains, Proceedings of the Philadelphia Academy of Natural Sciences, December, 1875.

fore he sat down to prepare his great scientific work on Peru for publication. This first volume is the key to the whole work, for it describes the methods and instruments used in the various branches of science, and contains a most interesting personal narrative of the author's numerous journeys, during nineteen years, over the length and breadth of the land. The work itself will consist of six parts. The first will be devoted to geography and meteorology, the second to geology, the third to mineralogy, the fourth and fifth parts to botany and zoölogy, and the sixth and last to ethnology, including descriptions of the architectural remains, pottery, arms, etc., of the different Peruvian tribes.

Recent Rise of the Peruvian Coast. — Interesting illustrations of the comparatively recent change in the coast level of Peru and the geographical changes resulting, are afforded by Mr. A. Agassiz in the last Bulletin of the Museum of Comparative Zoölogy. A number of corals were found by him at the height of from 2900 to 3000 feet above the level of the sea, at a distance in a straight line from the Pacific Ocean of twenty miles. From the general features of the country along the coast of Peru, it requires but little imagination to reconstruct the former internal sea formed by the Coast Range, which must have, within comparatively recent geological times, covered the whole of the great nitrate basin of Peru, and which has gradually been elevated to its present position. This inland sea then became a salt lake, afterwards a lagoon, and finally was entirely drained. While Darwin showed that beyond doubt the coast of South America has been recently elevated 800 feet, Mr. Agassiz believes that the elevation reached an altitude of at least 2900 feet, and in earlier times, judging by the marine nature of the fauna of Lake Titicaca, to an elevation of 12,500 feet.

MICROSCOPY.[1]

The Limits of Microscopic Vision. — In his recent annual address to the Microscopical Society of London, the president, Mr. H. C. Sorby, F. R. S., discusses the relation between the limits of the powers of the microscope and the size of the ultimate molecules of matter. As the combined result of observation and theory, he concludes that the normal limit of distinct visibility with the most perfect microscope is one half of the wave-length of the light. If so, even with the very best lenses (except under special conditions) light itself is of too coarse a nature to even enable us to define objects less than $\frac{1}{80000}$ to $\frac{1}{100000}$ of an inch apart. It would appear, therefore, that as far as this question is concerned, our microscopes have already reached their ultimate limit. Adopting the results as to the size of the ultimate molecules of matter arrived at by Mr. Stanley, Sir W. Thomson, and Professor Clerk-Maxwell, Mr. Sorby calculates that in the smallest interval which could be distinctly seen by the best possible microscope, there would be about

[1] This department is conducted by Dr. R. H. Ward, Troy, N. Y.

two thousand molecules of liquid water or about five hundred and twenty of albumen lying end to end; and that in order to see the ultimate constitution of organic bodies, we should requre a magnifying power from five hundred to two thousand times greater than those we now possess. He calculates that with our highest powers we are as far from seeing the ultimate molecules of organic substances as we should be from seeing the contents of a newspaper with the naked eye at the distance of a third of a mile. A spherical particle one tenth the diameter of the smallest speck that could be already defined with our best and highest powers, might nevertheless contain no less than one million structural molecules. Mr. Sorby makes a very interesting application of his results to Mr. Darwin's theory of pangenesis, his general conclusion being that no serious objection can be raised against the theory when examined from a purely physical point of view, as far as relates to the inheritance of a very complex variety of characters by the first generation. — A. W. Bennett.

Boston Microscopical Society. — This society held a public reception at Fraternity Hall, on the evening of April 27th, for the purpose of making better known its organization and aims. A short exhibition with the oxy-hydrogen microscope was given, in addition to the use of more than fifty table microscopes, with their accessory apparatus.

Exchanges. — [Notices, not exceeding four lines in length, of microscopical objects or apparatus wanted or offered in exchange, not sale, will be inserted in this column without expense.]

Arranged diatoms in exchange for good objects. Address offers to Christian Febiger, Wilmington, Del.

Extract of hop, mounted, showing lupulin crystals; in exchange for any mounted objects. Address Richard Allen, 146 North Fourth Street, Troy, N. Y.

SCIENTIFIC NEWS.

— Physicians will be interested in a work entitled Micro-Photographs in Histology, Normal and Pathological, by Carl Seiler, in conjunction with J. Gibbons Hunt, M. D., and J. G. Richardson, M. D., to be published in twelve number by J. H. Coates, of Philadelphia.

— At a late meeting of the Paris Geographical Society, Dr. Haney stated that a cavern containing numerous Caraïb remains had been discovered at the western extremity of Cuba, and that these proved that the whole of the island was at one time inhabited by that race.

— Professor Marsh publishes in the *American Journal of Science*, for June, a Notice of a New Suborder of Pterosauria. The group is distinguished by the want of teeth.

— Mr. A. R. Marvine, a geologist of much promise, has recently died. He was at the time of his death attached to Professor Hayden's Survey.

— The Smithsonian collections for the International Exhibition have been forwarded to Philadelphia from Washington. They are designed to illustrate the resources of sea and shore, of the chase and fisheries, in the United States. Specimens of all the animals in this country will be exhibited, and all the machinery of hunting and trapping will receive the amplest illustration. It is stated that there are forty-five hundred casts of food fishes now at the Smithsonian ready to be sent. The casts are made of plaster and papier mache, modeled from frozen specimens and from photographs. Among the other objects there will be a running screen of the size of eighteen hundred square feet, filled with photographs of American food fishes. The dresses of the fishermen in various climates, the varieties of flies used in catching trout, the fishing rod, the harpoon, and the lance, will all be shown. The chase of the whale will be fully explained by the plainest object lessons, and among the treasures is a cast showing the capture of a whale. The exhibition of furs will be one of the most remarkable ever seen on the continent. The useful products of our inland and foreign waters (other than vertebrates), have been arranged by Dr. Dall. Among these will be shell-fish, crabs, shrimps, corals, star-fish, sponges, and marine products not of an animal nature. Specimens of rare American animals and reptiles, and a group of lay figures intended to convey an idea of the character and habits of the North American Indians, will complete a very excellent collection.

PROCEEDINGS OF SOCIETIES.

National Academy of Sciences, Washington. — April 18–20. Professor Henry opened the public session by delivering the annual report which serves as a review of the year. It was confined to the official affairs of the Academy. The report of this year contains a touching allusion to the loss the Academy has sustained in the death of Prof. Joseph Winlock, the astronomer of Cambridge, Mass. Among the most prominent of the supporters of the Academy who have been called away by death during the past year was Vice-President Henry Wilson, who, although not a member, was one of the founders. He took a chief share in the preparation of the bill under which the Academy was organized, and urged its passage through Congress. Reviewing the present condition of the Academy, Professor Henry remarked that the plan by which its headquarters were fixed at Washington presented some inconvenience as a centre in comparison with larger cities; but there is no other place in the Union which contains so large a proportion of scientific men to its inhabitants, and the local society devoted to science is among the most prominent in the land. The establishment of the Johns Hopkins University at Baltimore, is now certain also to concentrate at no great distance from Washington a considerable band of prominent men of science.

There is also good reason to hope that means will be found to defray the expenses of non-resident members in traveling to and from the meetings.

The Academy, Professor Henry said, is becoming in a certain sense a leader of public opinion in respect to the expression of calm judgment and weight of scientific authority. This was its appropriate position. The recent instances in which the government has sought its aid were then briefly mentioned: its judgment had been required in respect to microscopic determination (with reference to collecting duties) of the proportions of wool imported in invoices of calves' hair; and it was estimated that a million of dollars would be saved to the revenue in consequence. Still more recently investigations had been ordered to ascertain the value of certain applications to the paper used in preparing fractional currency; and as to the crystallization of different grades of sugar, as a means for classifying them. The direction of the scientific part of the Polaris expedition was intrusted to the Academy. Dr. Emil Bessels has been engaged in preparing the material obtained for publication. Three volumes are nearly complete. They will contain the results in the departments of hydrography, meteorology, and astronomy. A fourth volume is in preparation, of which Admiral Davis has charge; this will contain the narrative of the expedition and much biographical information; its expense is borne by the Navy Department. The legacy left by Alexander Dallas Bache to the Academy has been applied, (1) to the preparation of a magnetic survey of the United States; (2) to observations on sun-spots, conducted at Cambridge, Mass.; (3) to certain researches on light and heat. The first of these undertakings is in a condition to report considerable progress. The map when completed will prove of important service for surveying purposes and topography generally, as it will determine the dip and direction of the needle for all localities. By the record of these data now, the students of the earth's magnetism will have a means in future years to ascertain the rate and laws of the great secular variations, as yet only imperfectly understood. The observations on the sun were conducted by the late Professor Winlock; since his death some arrangements have been projected for collating his work and continuing it. The researches on light and heat are carried on by Charles Peirce, a son of Prof. Benjamin Peirce. Part of the regular work of the Academy consists in having memoirs prepared of its deceased members, and the results of this work were stated.

The following papers were read: The Character of the Eocene Fauna of New Mexico, by E. D. Cope; A Conjectural Restoration of a Pueblo of the Mound Builders, by Lewis H. Morgan (in which he took the ground that the Mound Builders were village Indians who had migrated from the tropics, and that the mounds were the building-sites of their tenement-houses); The Geology of Petroleum, by J. S. Newberry; The Geological Evidence on the Question of the Cause of the Cold of the Ice Period, J. S. Newberry; The Geological Structure and Topographical Aspects of the Catskill Mountains, by James Hall; The Geological

and Physical Structure of the Black Hills, by Henry Newton; The Age of Mountains as determined by Degradation, by J. W. Powell.

Five members were elected, namely, Professors Langley, Peters, and Haldeman, General Warren, and Mr. Clarence King.

SCIENTIFIC SERIALS.[1]

The Annals and Magazine of Natural History. — April. Is there such a Thing as *Eozoön Canadense?* a Micro-Geological Investigation, by Otto Hahn. Descriptions of some New Species of Annelida from Kerguelen's Island, by W. C. McIntosh. Extinct Lemurina, by W. H. Flower. Note on the Embryogeny of *Salmacina Dysteri*, by A. Giard.

Archives de Zoölogie expérimentale et générale. — No. 4, 1875. Contributions à l'Histoire des Grégarines des Invertébres de Paris et de Roscoff, par A. Schneider. Recherches sur l'Appareil Circulatoire des Oursins [Echinus], par E. Perrier.

Zeitschrift für wissenschaftliche Zoölogie (Siebold und Kölliker). — March 6. Researches on Free-Living Nematodes, and the Genus *Chætonotus*, by O. Bütschli. On the Ontogony of Cyclas, and the Homology of the Germ-Layers in the Mollusks, by H. von Ohering. On the Silk-Glands of Lepidoptera, by F. E. Helm. On the Formation of the Blastoderm in the Spiders, by H. Ludwig. On the Challenger Expedition. Letter to Professor Siebold, by R. V. Willemoes-Suhm.

Petermann's Mittheilungen. — January 21st. The Ground Work of the Map of the Loango Coast, by P. Güssfeldt. The Geographical Convention in Paris, July 15 till September 16, 1875. The Southern Batta-Land of Sumatra, by A. Schreiber. Geographical Necrology of the year 1875. Journey to Araguay, by Dr. Couto de Magalhães, in January, 1865. March 1st. The Distribution of Sedimentary Rocks in Europe, by H. Habenicht. River Navigation in Southern New Guinea. Views from the High North, by Karl Weyprecht. The Mongols and the Land of the Tanguts. Przewalsky's Journey.

Monthly Microscopical Journal. — April. On a New Arrangement for Illuminating and Centring with High Powers, by W. H. Dallinger. The Identification of Liquid Carbonic Acid in Mineral Cavities, by W. N. Hartley. On some Structures in Obsidian, Perlite, and Leucite, by F. Rutley. On the Aperture of Object-Glasses, by F. H. Wenham. On Zeiss' $\frac{1}{25}$ Immersion, by W. J. Hickie.

Bulletin of the Museum of Comparative Zoölogy. — III., Nos. 11–14. Exploration of Lake Titicaca, by A. Agassiz and S. W. Garman. I. Fishes and Reptiles, by S. W. Garman. Notice of the Palæozoic Fossils, by O. A. Derby, with Notes by A. Agassiz. Recent Corals from Tilibiche, Peru, by A. Agassiz and L. F. Pourtales. The Development of Salpa, by W. K. Brooks.

[1] The articles enumerated under this head will be for the most part selected.